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HOME RANGE OF ELEPHANTS IN FRAGMENTED HABITATS OF CENTRAL INDIA[1]

HEMANT S. DATYE[2] AND A.M. BHAGWAT[3]

(*With four text-figures*)

Key words: home range, range fidelity, habitat, degradation, fragmentation, central India.

Home range of three adult bulls and one adult female (and her clan which included her family unit and associated family units) living in Dalma Wildlife Sanctuary, Bihar were studied from 1989-1992. All animals were identified visually and their locations were digitized and analyzed using Spacial Ecology Analysis Program (SEAS). One bull represented the resident population of 16 elephants, whereas the remaining two and the female represented migratory population of 50 elephants.

Analysis of home range pattern showed that considerable part of home range of all the individuals of the whole population lie outside the sanctuary limits. The home ranges expanded to the maximum in winter and shrunk to minimum in summer. The expansion was always along the long axis of home range. The resident population expanded the home range towards west and to a lesser extent towards north and the migratory population to the east. Existing traditional routes might be one of the factors influencing such directional expansions. Knowledge of home ranges of elephants, especially in fragmented areas, could be a key to solve many problems associated with elephant management.

INTRODUCTION

The ranging behaviour of elephants has been studied in different parts of Africa and Asia. The African studies were started by Douglas-Hamilton 1973, 1975, Leuthold and Sale 1973, Leuthold 1977b, Merz 1986a, Dunham 1986, Hall-Martin 1987, Viljoen 1989, and mainly described the size of the home range in relation to environmental factors, vegetation, shape and spatial distribution. The fidelity to the home range was studied by Wyatt and Eltringham (1974), Leuthold (1977b), and Viljoen (1989).

In Asia, home ranges were studied by Khan 1967, Olivier 1978, Sukumar 1985, 1989a, 1989b; Easa 1988, and Desai 1991. Olivier (1978) studied home ranges of elephants in Malaysian primary and secondary rain forests. Easa (1988) carried out similar studies in forests of Kerala state. Sukumar (1985, 1989a, 1989b) estimated home ranges of clans and bulls in the eastern ghat area, using Minimum Convex Polygon method. Management issues like identification and maintenance of corridors that link sub-populations were studied by Desai (1991).

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[1] Accepted March 1995.

[2] C-5 Samant Blocks, Ghantali, Naupada, Thane 400 602.

[3] Vice-Principal, Ramniranjan Jhunjhunwala College, Ghatkopar, Bombay 400 086.

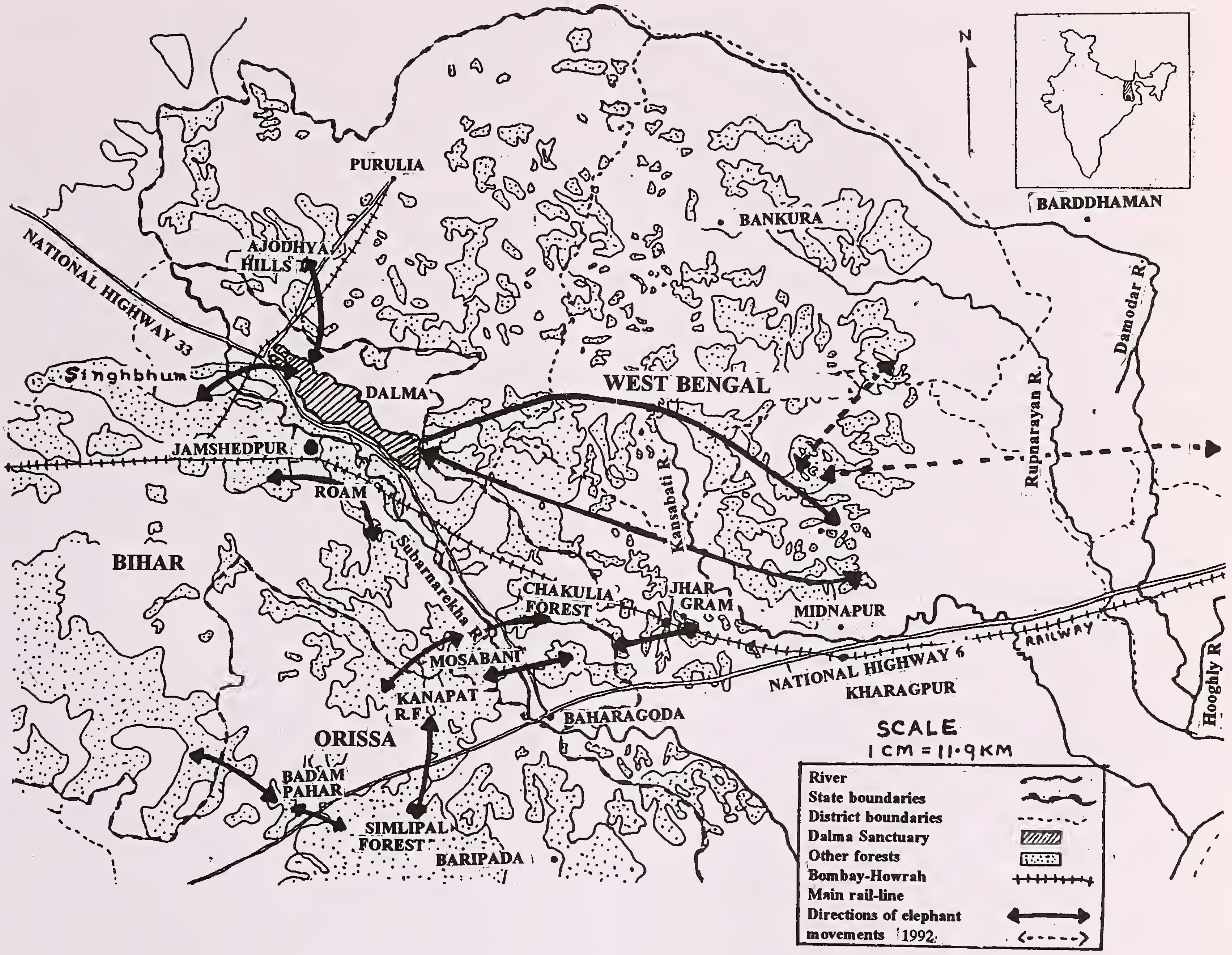
A review of the literature on the ranging pattern of elephants reveals that information on home ranges of elephants in fragmented areas, where the habitat was/is rapidly lost to urban development and was/is continuously degraded, is not available. In India, there is no protected area for elephants as small as Dalma Wildlife Sanctuary (193 sq. km), having heavy biotic pressure. The Chandka Wildlife Sanctuary in Orissa is also as small but with negligible biotic pressure at the present. The ranging of elephants in such a habitat as Dalma has an additional component of seasonal migration of 75 % of the population to the plains of West Bengal for 5 to 6 months of the year. Therefore, it was important to study home ranges and of elephants in the fragmented areas for better management planning.

The objectives were:

1. To find the size and extent of home ranges of some identified elephants of the Sanctuary.
2. To determine the fidelity of the individual animals to their home ranges.
3. To ascertain the factors influencing the size of the home ranges.
4. To estimate the overlaps of the individual home range and the Sanctuary, i.e. to find how much of the home range lies outside the Sanctuary, in agricultural land, and inside the Sanctuary.

STUDY AREA

The study was undertaken in Dalma Wildlife Sanctuary and surrounding elephant areas of the Chhotanagpur Plateau in the state of Bihar and in the migration range of elephants of the Singhbhum district into the plains of West Bengal. The major elephant ranges in Bihar other than the Dalma Wildlife Sanctuary are Palamau National Park, Porahat, Kolhan, Saranda, Roam and Mosabani reserved/protected forests, most of which are fragmented and severely degraded. The Dalma Wildlife Sanctuary is spread between 22° 5.30' N to 22° 57' N and 86° 7' E to 86° 20' E on the Chhotanagpur plateau in south Bihar and it is adjacent to the tri-junction of borders of the states of Bihar, Orissa and West Bengal (Fig. 1). The range of elephants of Dalma Sanctuary extends into plains of West Bengal covering parts of Purulia, Midnapur, Bankura, and to a lesser extent Bardhaman and Hoogli districts. In Bengal the natural forests exist only in small patches of few hectares mainly in the western part adjoining Bihar. Most other forest patches consist of sal monoculture that are in a state of severe degradation, though in some places there are signs of recovery due to protection provided by local villagers. The essential feature in the physical aspect of the elephants' habitats in Bihar, is the prevalence of plateaux and hills, often rising into mountains which rarely exceed 1000 metres in elevation. The forest of Dalma belongs to a unique *Shorea-Cleistanthus-Croton* series (Gadgil & Meher-Homji 1986). The Champion-Seth classification shows the forest as consisting of dry peninsular hill sal, and northern mixed dry deciduous type. The forests of the Chhotanagpur plateau exhibit a variety of habitat types ranging from dry deciduous to evergreen though the study area constituted only dry deciduous type of forest. The whole study area being a tribal belt is inhabited by several different tribes, each having a distinctive tradition, language and culture. The area is extremely backward in spite of being the most mineral rich area of India, producing copper, uranium, iron ore, coal, gold and many other important minerals. In fact this area generates a fourth of the total mineral produce of the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Rupnarayan R.
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RAILWAY
BADAM PAHAR
SIMLIPAL FOREST
BARIPADA
SCALE 1 CM = 11·9 KM
River
State boundaries
District boundaries
Dalma Sanctuary
Other forests
Bombay-Howrah Main rail-line
Directions of elephant movements 1992

Fig. 1. Location of the study area and general directions of movement of Dalma Sanctuary elephants.

country. However, it lacks in basic amenities like medical facilities, education, potable water supply, electricity, transport and education in most places. The rapid industrialization due to the presence of vast deposits of a variety of minerals has resulted in economic disparity between the urban 'outsiders' and the tribals. Since 1914, the tribals of the plateau have been demanding an independent tribal state called 'Jharkhand' and the agitation has/had taken violent turns in the last and the present decade. The anger against the ruling government was often redirected towards the state owned forests, by felling the trees indiscriminately. The forests of the area which were rich in flora and fauna are giving way to mining activities in many places and almost all the forests are under various degrees of biotic pressure. This has resulted in shrinking and degradation of the elephant habitat, forcing elephants to move out of the traditional habitat, to raid crops to meet their energy requirements and to seek better habitat elsewhere.

METHODOLOGY

The ranging behaviour of elephants has been studied through different methods. In

Africa, visual resightings of identified individuals was used to determine home ranges (Douglas-Hamilton 1975, Viljoen 1989). In Asia, particularly in India, a similar method was used by Sukumar (1985, 1989a, 1989b); Easa (1988), Daniel *et al.* (1987); and Desai (1991). Coloured collars (Daniel *et al.*, 1987), coloured and notched radio-collars (Dunham 1986), body painting (Jones 1975, Rodgers and Elder 1977) were also used in the study home ranges. The most successful method, according to several studies, is radio-telemetry. In Africa, this method was used by Leuthold and Sale (1973), Leuthold (1977), Douglas-Hamilton and Douglas-Hamilton (1975) and Dunham (1986). In Asia, this has been used by Olivier (1978) in Malaysia and by Desai (1991) in India.

The present study: The data on home range of elephants for this study was gathered between 1989 to 1992. Radio-telemetry, though a better method, was not employed in this study because of the unfavourable cost/benefit ratio. The elephants of the study area, due to their constant interaction with people, had good chances of getting killed, especially in the migration range in the state of West Bengal. This would have defeated the purpose of collaring. Another important point was, in fragmented areas it was not difficult to locate the elephants, once they were out of the forests. Therefore the home range values calculated using radio-telemetry data and visual resighting data would not show a significant difference in fragmented areas as it does in areas having vast stretches of forest. However, sightings within the Sanctuary had limitations because of the visibility and the home range size could be underestimated in such situations, for seasonal ranges. A considerable amount of time is used in locating the herds, due to the terrain and undergrowth and the inherent problem of identifying the herd and then the required individual. This can be definitely avoided in radio telemetry.

For the present study, four identified elephants were selected for the home range estimation, of which 3 were adult males and one adult female. The female was named as Long Cut Ear (LCE), after the deep cut in her longish ear. The three males had human names : Arjun, Ganesh and Gabbar and were identified by their individualistic body characters. The elephants were tracked on foot, and a record of resightings, within the DWS and beyond in the migration and raiding ranges, was maintained. The sightings were maximum during the summer months followed by rains and Winter. The female (LCE) had her accompanying clan whose number varied from season to season, according to the number of family units joining or breaking away. [A clan is considered as a group of elephants having a coordinated movement and is believed to be related (Moss 1988).]

All the elephant resighting locations were digitized along with the map of the study area with the help of a digitizer pad attached to a computer. The locations were then analyzed and the home range sizes and the overlaps were calculated with the help of a software SEAS (Spatial Ecology Analysis System) developed by John Carey, Wisconsin University, U.S.A. All the home ranges were calculated using the Minimum Convex Polygon (MCP) .method. Other methods- 95 % Ellipse and Harmonic Mean Transformation were also experimentally tried and compared. The choice of MCP over the other two is discussed in the results.

Home range size: Several techniques have been developed to analyze the home range of animals. All these techniques are divided into, based on statistical considerations, parametric estimators and non-parametric estimators. The best and the most extensively and popularly used non-parametric method, the Minimum Convex

Polygon (MCP) (Mohr 1947) is used here to estimate the size of individual home ranges and their overlaps, where the 'Convex' is defined as a figure having no inner angle greater than 180 degrees.

Fidelity to home range: The general pattern of home ranges was established by the end of the first year. The following years of observations were used to check the fidelity of the known individuals to the over all home range and the seasonal home range. The crop raiding areas were visited every year, around the DWS and the migration range in the state of West Bengal, to locate the identified individuals.

RESULTS AND DISCUSSION

Home range size: The home ranges were estimated using the Minimum Convex Polygon (MCP) Method (Mohr 1947). The other two methods, 95 % Ellipse (Jenrich and Turner 1969) and Harmonic Mean Estimator (Dixon and Chapman 1980), were also tried but the calculated home range projections included areas like Jamshedpur town and other known non-elephant areas within their limits. Comparatively, the MCP method gave very logical results and the general axis of all the home ranges was close to what was permitted by the physical limits of elephant movement. The home range of the 4 individuals [3 males and 1 female (clan)] were defined only for the study period of three and half years. The home ranges of individual years were not plotted as the number of sightings were inadequate. As such, all the migratory elephants, including three of the study individuals, have been expanding their home range on the eastern side, every year since 1987 till the end of the study in 1992. Therefore, the observation time-area curve could not reach an asymptotic value and did not flatten out.

However, the summer ranges did not increase significantly as the elephants stayed within the Sanctuary throughout the summer. In an area like DWS where elephants are moving out in search of a better habitat, possibly for colonization, the curve is not expected to stabilize till the elephants reach a suitable habitat or can not move further in any direction due to real physical barriers. The tremendous difference in the home ranges of the first and the last 3 animals (Table 1) is because the latter (Gabbar, Ganesh and LCE) migrated every year to West Bengal during late rainy season, unlike Arjun who stayed back in Bihar, and raided crops locally, in and around the western part of Dalma Sanctuary. Arjun's home range size falls

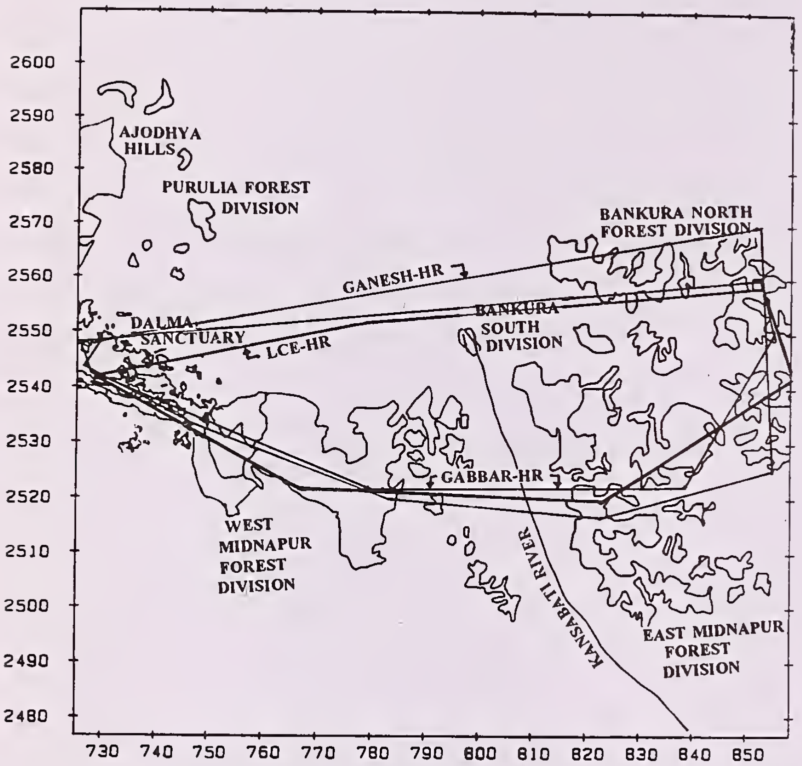
TABLE 1
HOME RANGE SIZES OF THE STUDY ANIMALS

Study animal	No. of sightings	Area of Home range in sq. km using MCP	Unit
Arjun	41	258.60	Bull
Gabbar	39	3343.19	Bull
Ganesh	18	4348.99	Bull
LCE	31	3396.14	Clan

TABLE 2
CALCULATED AND MAXIMUM SUMMER RANGES OF THE STUDY ANIMALS

Name of the elephant	Calculated summer range (MCP) in sq. km	Maximum possible summer range in sq. km	
		On sunny Days	On cloudy/rainy days
Arjun	23.75	35	55
Gabbar	28.27	35	55
Ganesh	04.54	35	55
LCE	22.67	35	55

within the home range sizes exhibited by study elephants at Mudumalai Sanctuary (Desai 1991) and by adult bulls in deciduous forests of eastern ghats (Sukumar 1989). The large overall home range sizes exhibited by the other three study animals are similar to those shown by elephants of Northern Namib Desert region of Kaokoveld (Viljoen 1989). Home range size normally varies with the habitat type. However, habitat condition and environmental factors may influence the home ranges to a considerable extent especially in fragmented habitats.


2600
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2490
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770
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790
800
810
820
830
840
850
AJODHYA HILLS
PURULIA FOREST DIVISION
BANKURA NORTH FOREST DIVISION
GANESH-HR
DALMA SANCTUARY
LCE-HR
BANKURA SOUTH DIVISION
GABBAR-HR
WEST MIDNAPUR FOREST DIVISION
KANSABATI RIVER
EAST MIDNAPUR FOREST DIVISION

Fig. 2. Home range of elephants of Dalma Sanctuary (Ganesh, Gabbar, LCE, 1989-92).

Although the migratory elephants (Gabbar, Ganesh, LCE) did not show significant variation in the home range size, they utilized the area within the home range differently in different years. Fig. 2 shows the overall home range of these 3 individuals. On the left edge of the map is the Dalma Sanctuary. None of these 3 elephants ever used the western part of the Sanctuary (west buffer) or raided crops in the area to the west of DWS. On the contrary, Arjun utilized the western part (west buffer) and the core area of the Sanctuary extensively and raided crops only in the area surrounding the west buffer zone and the area southwest of the Sanctuary (Fig. 3). The 'Core area' of elephant usage was not estimated in this study. Similar studies in south India showed the 'Core area' to be 21.3% to 36.7% of the total home range, for the studied individuals (Daniel *et al.* 1992). In case of the migratory elephants this might be more than 75% of the total estimated home range. The LCE group and other family units migrating to West Bengal, all totalling about 45 individuals, also showed similar home range patterns. One group of 12 individuals (two family units), that stayed back in Bihar throughout the winter and never migrated to the east, to Midnapur in West Bengal, but instead shuttled between the Sanctuary and the Ajodhya hill in Purulia district of West Bengal.

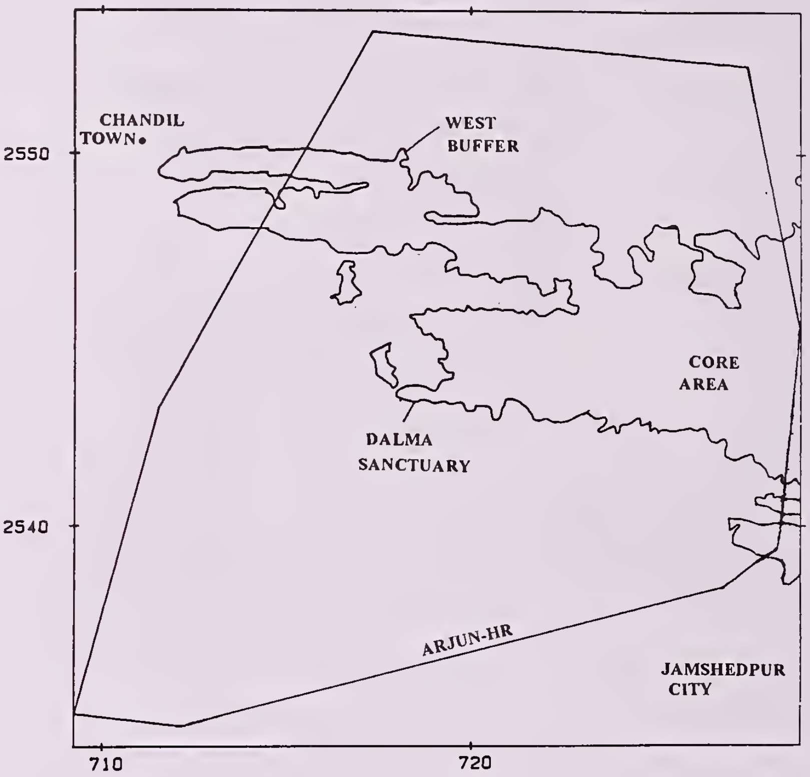
2550
2540
710
720
CHANDIL TOWN
WEST BUFFER
CORE AREA
DALMA SANCTUARY
ARJUN-HR
JAMSHEDPUR CITY

Fig. 3. Home range of elephant of Dalma Sanctuary (Arjun, 1989-92).

Factors influencing home range size: All the individuals studied showed seasonal variation in ranges. The summer ranges were the smallest (Table 2) for all the four individuals (Fig. 4).

This was because the Chhotanagpur Plateau has extremes of temperature and almost all waterholes in the buffer zones dry up. The high ambient temperatures force the elephants to take refuge in the Sanctuary core which is 55 sq. km in area. Of this 55 sq. km. only the northern slopes, which have an area of approximately 35 sq. km, are used on sunny days (most days of summer) as they are comparatively cooler than the southern slopes (Table 3) and hold most of the big waterholes. So effectively elephants were contained in an area of approximately 35 sq. km throughout summer.

TABLE 3

AVERAGE TEMPERATURE AT NOON ON THE DALMA SLOPES IN SUMMER

Name of the Location	Slope	°C in open	°C in shade	°C in water
Majhla bandh	North	46.2	40.4	28.7
Nichla bandh	North	47.6	35.4	26.2
Aamdadi	North	45.6	33.4	22.9
Bijli ghati	North	40.2	31.3	28.4
Snan ghati	North	43.5	34.8	29.9
Ghusi jharna	North	42.0	38.8	26.0
Aamda Pahadi	South	50.8	32.6	26.6
Megha doha	South	55.9	39.7	28.5
Chagal Topa	South	49.7	36.9	27.9
Nutandih	South	56.7	49.7	27.7
Bhelatal	South	51.1	40.1	dry

They visited the southern slopes of the hill during night only sporadically when there was no forest fire, as the exposed rocks on the southern side gave out heat during the night, and forest fires only added to the ambient temperature. So the maximum area of the summer range could be 55 sq. km, if one includes the southern slopes where the elephants made forays only during the summer showers or overcast conditions with cool winds blowing. Moreover, there were more number of water holes on the northern slopes than the southern slopes. Due to the low tree density on the southern slopes, there was generation of `gaps' in the forest canopy, which reduced the total available shade. The bigger the gap the greater the solar radiation on the forest floor and the greater the changes in the other facets of microclimate above and below the ground, from conditions beneath the closed canopy. Wien (1985) recorded the microclimatic (temperature) difference and its influence on the birds and mammals that showed a marked preference of study animals to low direct radiation areas in the extreme climate. The daily variation in the ground temperature is much higher in denuded areas compared to the land under forest. Studies in Singapore revealed higher temperatures at all depths from 3 to 50 cm in the bare soil, slightly less under grassland and lowest and the least variable under forests (Meher-Homji 1991). The forest fires were more common on the southern than the northern slopes due to low humidity on the former as a result of low tree cover and relatively high grass cover adding to overall surface temperature.

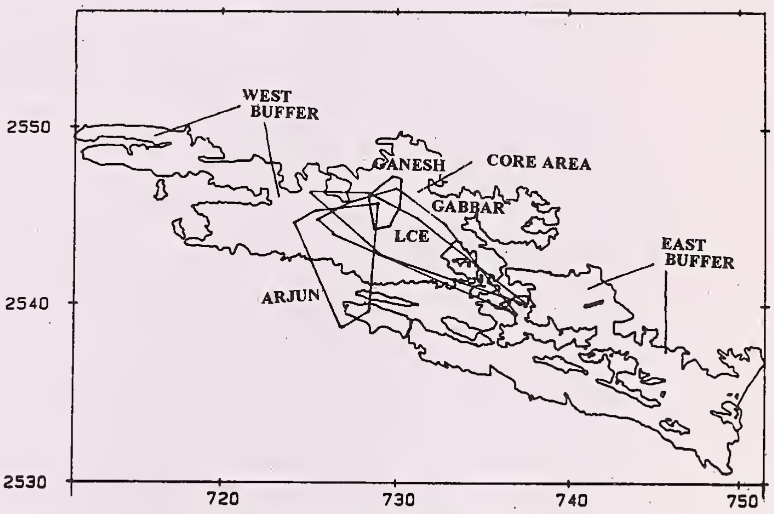

Fig. 4. Summer range of elephants of Dalma Sanctuary (Arjun,, Gabbar, Ganesh, LCE, 1989-1992).

The summer ranges of Arjun, Gabbar and LCE did not differ significantly, however, summer range of Ganesh differed significantly from the other three. The small summer range of Ganesh could be because of the territoriality of the Big Bulls Arjun and Gabbar (both 35+ age class), who came into musth during the summer months. Ganesh being of a younger age class (18-20) was probably keeping away from the big bulls in the small core area.

A study in the Mudumalai Sanctuary showed that the musth range of the adult bull overlapped most of the area of its total home range (Daniel *et al.* 1992). The musth ranges of the adult bulls studied during the present investigation also overlapped and were very small. However, this was not a problem because all the adult females in oestrous were present in the same area.

This small area of 35-55 sq. km was the only place that offered food to the elephants during the entire summer. The forest area was exploited by the elephants to the fullest as there was little in the agricultural lands around the sanctuary to supplement their forest diet. At the end of summer the elephants were in run-down condition possibly due to low availability of quality food due to over exploitation of forest resources. At the onset of the rainy season, the temperature on the southern slopes dropped due to the cloud cover, and elephants immediately moved to the southern slopes to exploit whatever grass that was available and also other food tree species. The bulls moved down to the edges of the forest as the monsoon progressed and started raiding paddy. At this point the home ranges started expanding. The rainy season ranges were not calculated due to lack of sufficient sighting locations but could be roughly estimated to be around 150-200 sq. km. Arjun moved westward of the Dalma Sanctuary after the initial forays on the southern fringe of the sanctuary; whereas Gabbar, Ganesh and LCE expanded their ranges on the east, from July onwards.

Fidelity to home range: The three study animals (Gabbar, Ganesh, LCE) were located in the same areas of the western part of their home range in the succeeding years (summer and rain range in Bihar). The winter ranges were expanding throughout the study period and between the years the locations in the migration range (winter range) though lying in the same area changed localities. The reason for this, in case of the three migratory animals was that probably the herds and the bulls were chased randomly by the people and the officials of the forest department and hence could not reach the same locality every year in West bengal, although the general area of visit was same. Arjun and a family group visiting Ajodhya hills, maintained absolute fidelity to their home range in the western part of the Sanctuary. In Bihar, the elephants were not chased as they were in West Bengal and this was one of the reasons for their fidelity to the home range. Gabbar, Ganesh and LCE never visited the western part of the sanctuary that includes western buffer of Dalma Sanctuary. In fact other family units associated with LCE also never moved to the western buffer throughout the study period. Similarly Arjun and a family group that stayed back in Bihar (not included in this home range study) never visited eastern part of Dalma Sanctuary. Thus even in the face of extreme degradation and fragmentation (Datye 1993) these study animals maintained fidelity to their home ranges. It will be interesting to see what happens to home ranges of such animals when the sanctuary is totally unable to support them in future due to loss of vegetation cover and food species.

Axis of the home range and linear expansion: The home range of all the elephants migrating to West Bengal showed a NW-SE axis to their home range. Arjun showed NE-SW axis and the Ajodhya group showed a N-S axis. The linear expansion in home ranges is shown in Table 4. The linear expansion difference was statistically insignificant between the years 1988 and 1989 but the differences in linear expansion between 1988 and the years 1990, 1991 were statistically very significant.

TABLE 4
LINEAR EXPANSION IN KM OF HOME RANGES OF THE STUDY ANIMALS

Direction	1988*	1989	1990	1991	Extreme
East	83	113	137	143	250
West	-	06	05	06	06
North **	-	21	26	24	26
South	-	0	0	0	0

* Past record of the Forest Department.

** Ajodhya hill family group not included in the home range estimation due to lack of sufficient observations. However, Linear expansion is based on the report from the northern most point of their visit.

The expansion of the home range on the west and north side is insignificant probably because elephants went to these areas only for crop raiding and not for exploration of a suitable habitat. On the other hand, the elephants expanded their home ranges considerably on the east, for exploration and search for a better habitat in the face of rapid degradation of the DWS, as an extension of their traditional seasonal range to east of the Sanctuary, in the west Midnapur area. Such a traditional seasonal range apparently did not exist in the west of DWS. The migrant population obviously had a different strategy than the resident Bihar population.

Home range overlaps with Sanctuary: All the study individuals showed that a very significant part of their home ranges lies outside the DWS. Arjun had 77.29%, Gabbar had 96.95%. Ganesh had 97.47% and LCE 96.45%, overlap on the agricultural areas outside the Sanctuary. Even if the agricultural overlap, calculated using MCP method, is considered to be much more than the actual area of usage, the area of the Sanctuary overlap would be less than that of the agriculture. These overlaps indicate not only poor carrying capacity of the sanctuary but also point to the fact that the present area of the sanctuary may be a fragment of what was once the original habitat of Dalma elephants that has come under human encroachment.

The knowledge of home range of elephants in fragmented areas thus throws light on the real utility of such 'fragments', termed as sanctuaries in many places, to the elephants and could be used in knowing the preferred areas of elephants, for better management.

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COMMUNITY STRUCTURE OF BIRD PESTS AND THEIR DIURNAL RHYTHM IN RIPENING SORGHUM[1]

B.M. PARASHARYA, K.L. MATHEW AND D.N. YADAV[2]

(*With a text-figure*)

Key words: bird pest, community, damage, diurnal rhythm, sorghum, species diversity

The species of birds and the maximum number that fed on isolated fields of standing sorghum, *Sorghum vulgare* were recorded from 0700 to 1800 hr and their community characters were determined. A total 12 species of birds fed on standing sorghum. The Baya *Ploceus philippinus*, Rose Finch *Carpodacus erythrinus* and Spotted Munia *Lonchura punctulata* constituted 75.22% of the total bird species. The feeding pattern was bimodal with morning and evening peaks. The density of birds, species richness, their diversity and evenness were greater during the morning peak as compared to that of the evening. The bird density and the species richness were extremely low during the noon hours. Therefore it is suggested that morning is the best time to study the bird community and morning as well as the evening foraging periods are the times a ripening field requires maximum protection. The estimated percent damage inflicted by birds ranged from 38.54 to 73.93.

INTRODUCTION

Sorghum *Sorghum vulgare* and pearl millet *Pennisetum typhoides* are the two important cereals heavily depredated by birds. Seeds of these crops are exposed and so attract several bird species during the entire period of seed setting to harvesting stage and so suffer heavy losses.

Bird pests of sorghum have been identified and the extent of damage to this crop has been reported in India (Rao and Rao 1953, Perumal *et al.* 1971, Mehrotra and Bhatnagar 1979, Santhaiah *et al.* 1983, Dhindsa *et al.* 1984, Dodia *et al.* 1989) and elsewhere (Manikowski and Da Camara-Smeets 1979, Brugger 1980). Dhindsa *et al.* (1984) reported on the bird community structure of sorghum and pearl millet at Ludhiana and estimated the damage inflicted by them. However, there exists no information on the diurnal rhythm of the feeding activity of pest birds on any of the crops. This paper deals with the diurnal feeding rhythm of pest birds on sorghum grown in isolation and the extent of damage caused by the pests. It is necessary to know the diurnal rhythm of bird communities associated with cereal crops at their ripening stage since it would be useful in evolving and employing different control strategies and methods. Such knowledge on the timing of bird activities in crop fields would be helpful in designing studies on the population dynamics of birds in ripening cereal fields too.

MATERIALS AND METHODS

This study of the diurnal rhythm on the feeding activity of birds damaging sorghum *Sorghum vulgare* was carried out at the college farms of Gujarat Agricultural University, Anand (22° 32' N, 73° 00' E) from 20 November to 10 December 1984. The observations were recorded from 1330 to 1800 hr on a day and were followed up on the next day from 0700 to 1330 hr to complete one day cycle. During the study

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[2] All India Coordinated Research Project on Agricultural Ornithology, Gujarat Agricultural University,
Anand 388 110, Gujarat.

period, sunrise was at 0705 hr and 0720 hr on 20 November and 10 December whereas sunset was at 1800 hr and 1802 hr respectively. The maximum temperature ranged between 29.5° and 33.6°C and minimum temperature ranged between 8.5° and 17.5°C. The maximum number of birds feeding on grains were recorded during every 30 minutes block. The results are based on seven days observations recorded on 3 different fields (0.10-0.55 ha area). The birds were identified and counted using 7 x 30 binoculars from at least 2.0 m height above ground. The species diversity (H') and evenness of the species (J) were determined using Zar's (1974) method. Sorghum was the only cereal crop grown, mainly as fodder. During the study period, other cultivated crops were Tobacco *Nicotiana tabacum*, Sugarcane *Saccharum officinarum*, Pigeon-pea *Cajanus cajan* and Cotton *Gossypium hirsutum*.

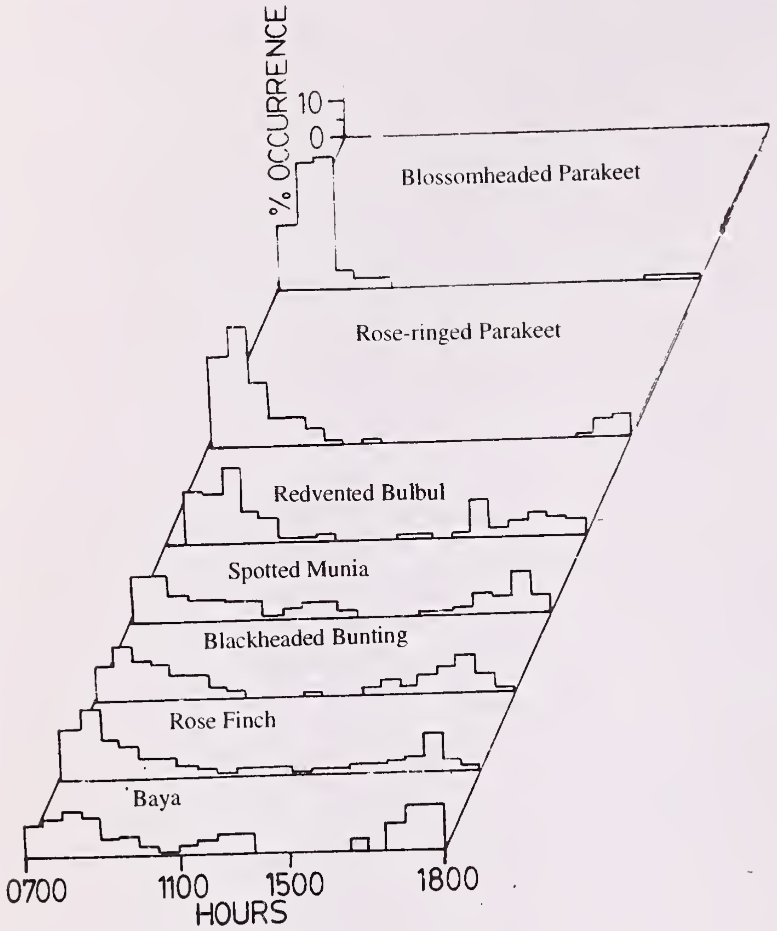

Fig. 1. Diurnal rhythm in the feeding activity of granivorous birds in sorghum fields.

The damage caused by birds was estimated by moving across the field from one end to the other in a zigzag fashion. After an equal distance of walking, the earheads touching the 1 m stick raised at breast height were considered for estimating the damage. All the earheads were cut and brought to the laboratory. Besides working out the percentage of earheads damaged, overall damage was also calculated by counting the total number of seeds present and those missing in the earheads damaged by the birds. Parakeets cut the earheads, the number of seeds missing were extrapolated from the average number of seeds per earhead.

RESULTS AND DISCUSSION

A total of 12 species of birds were identified feeding on sorghum grains during the study. Only 7 species occurred in fairly large numbers and showed definite feeding pattern (Fig. 1 and Table 1), whereas the remaining species were only few in number. The three major species, the Baya *Ploceus philippinus*,

TABLE 1

RELATIVE ABUNDANCE OF BIRDS FEEDING ON SORGHUM AND THEIR COMMUNITY CHARACTERISTICS

Species	Relative Abundance (%)
Baya	29.33
Rose Finch	22.76
Blackheaded Bunting	8.37
Redheaded Bunting	1.10
Spotted Munia	23.13
Whitethroated Munia	0.06
Redvented Bulbul	4.34
Common Babbler	0.73
Jungle Babbler	1.10
Large Grey Babbler	1.50
Roseringed Parakeet	5.38
Blossomheaded Parakeet	2.20

Rose Finch *Carpodacus erythrinus* and Spotted Munia *Lonchura punctulata* constituted 75.22% of the total birds counted. Species diversity (H') of the birds encountered in the field and its evenness (J) were 0.791 and 0.739 respectively. All the birds started feeding soon after sunrise and stopped completely after sunset.

The Baya fed mainly from 0700-0900 hr and from 1630-1800 hr. There was absolutely no activity between 1300 and 1530 hr. They roosted in nearby sugarcane field and a few individuals intermittently fed between 0900 and 1300 hr. The feeding activity of the Rose Finch was recorded throughout the day but the peak activity was from 0700-1030 hr and 1630-1700 hr. The Spotted Munia and Blackheaded Bunting *Emberiza melanocephala* also showed a similar pattern of foraging as that of the Rose Finch. The finches and buntings took shelter in the adjoining Pigeon pea field during hours of the day and from there, a few birds visited the field occasionally. Feeding hours of the Roseringed Parakeet *Psittacula krameri* and Blossomheaded Parakeet *P. cyanocephala* were restricted in the morning between 0700 and 0930 or 1000 hr; it was much shorter in the evening. The Redvented Bulbul *Pycnonotus cafer* also showed bimodal feeding pattern.

The results incorporated in Table 2 show that the feeding pattern of birds associated with the sorghum field is bimodal with high activities during the morning and evening hours. However, when the species richness, diversity (H') and evenness (J) were compared, it was maximum between 0700 and 1000 hr (morning peak) as compared to that of 1600 to 1800 hr (evening peak). When the species richness was considered it was poor between 1030 to 1530 hr. But as the species richness, diversity and evenness were taken into account, it is obvious that the avian activities in the field were at a minimum from 1230 to 1430 hr. Since the highest number of species was 5 and the evenness of species was nearer to 1 during the noon hours, it was concluded that only a few species were present in the field during that time of the day and their numbers were almost even. But the bird density was the least (Fig.1). Therefore the field did not require much protection against birds at this time and also this was not the right time to study and conduct bird census. On the contrary, the number of species observed was the maximum during the morning peak with greater values of diversity and evenness even to that of the evening peak. Thus it could be considered that the morning hours between 0700 to 1000 hr as the best time to study the bird community in a ripening sorghum field. Moreover, this is the period of the day together with the evening peak period during which a field requires maximum protection against bird pests to make the scaring more effective and economical.

Peak feeding hours of the birds may change with the season and changing day length period. The birds are seasonal breeders and hence higher food requirement during such periods may influence their feeding rhythm. Therefore, it is essential that the diurnal feeding pattern of birds is determined in all the seasons so that right scaring time could be determined. Several behavioural and physiological functions follow circadian rhythms. Consequently the feeding activity of many of the birds exhibits a bimodal pattern with peaks in the morning and evening. The morning peak may be for making up the deficiencies built up during the previous night of starvation whereas the evening peak for enabling the bird to store energy in surplus for the coming night (Gwinner 1975).

Among the 12 species recorded damaging sorghum in the present study, a few have already been reported from other parts of the country (Bhatnagar *et al.* 1982, Santhaiah *et al.* 1983, Dhindsa *et al.* 1984) the Redvented Bulbul and

TABLE 2

DIURNAL VARIATIONS IN THE COMMUNITY CHARACTERS OF BIRDS FEEDING ON SORGHUM

Time (hr)	Average no/obs.	Species richness	Diversity (H')	Evenness (J)
0700-0730	48.57	7	0.720	0.852
0730-0800	65.00	9	0.809	0.848
0800-0830	54.14	10	0.836	0.836
0830-0900	41.28	9	0.792	0.830
0900-0930	24.57	9	0.840	0.880
0930-1000	24.42	10	0.776	0.776
1000-1030	13.57	7	0.626	0.741
1030-1100	04.28	4	0.508	0.843
1100-1130	07.57	6	0.590	0.758
1130-1200	11.28	6	0.574	0.738
1200-1230	15.14	5	0.569	0.815
1230-1300	12.28	4	0.470	0.781
1300-1330	01.57	4	0.562	0.934
1330-1400	02.28	5	0.614	0.878
1400-1430	03.00	4	0.584	0.969
1430-1500	06.14	5	0.609	0.871
1500-1530	06.00	5	0.623	0.891
1530-1600	13.71	7	0.713	0.844
1600-1630	18.57	7	0.693	0.820
1630-1700	32.00	8	0.664	0.786
1700-1730	35.85	8	0.604	0.664
1730-1800	28.28	7	0.487	0.576

three species of babblers namely Large Grey Babbler *Turdoides malcolmi*, Jungle Babbler *T. striatus* and Common Babbler *T. caudatus* are being reported for the first time. Earlier Toor and Saini (1986) had analysed the gut of Large Grey Babbler at Ludhiana and reported grains of wheat *Triticum aestivum* and paddy *Oryza sativa*, however, the grains of sorghum were not recovered from the gut and its status as a pest of standing crop was not established. As in the present study, the Whitethroated Munia *Lonchura malabarica* has already been observed damaging sorghum from Andhra Pradesh (Perumal *et al.* 1971, Santhaiah *et al.* 1983) and Punjab (Dhindsa *et al.* 1984). The Rose Finch and Blackheaded Bunting as well as Redheaded Bunting *Emberiza brunniceps* are winter migrants whereas the remaining species are residents.

The present report of damage estimation was only on crops grown under isolated condition. Though the extent of damage varied from 38.54% to 73.93% with variation in the extent of damage depending on certain environmental factors (Mathew *et al.* 1991). Such high degree of damage was mainly attributed either to the isolated condition or leaving the fields unwatched. The identification of bird pests and the extent of damage due to them to sorghum have been done in other parts of the country (Rao and Rao 1953, Perumal *et al.* 1971, Santhaiah *et al.* 1983, Dhindsa *et al.* 1984, Mehrotra and Bhatnagar 1979, Dodia *et al.* 1989). Most of these studies including the present one deal with the estimation of damage in a small area under isolated condition if not mentioned otherwise, and hence do not represent the nature or extent of damage caused by birds to sorghum in general.

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STATUS, DISTRIBUTION AND CONSERVATION OF THE TRAVANCORE TORTOISE, *INDOTESTUDO FORSTENII* IN WESTERN GHATS[1]

S. BHUPATHY[2] AND B.C. CHOUDHURY[3]

(*With two plates and a text-figure*)

Key words: *Indotestudo forstenii*, Travancore tortoise, Western Ghats, endemic species, conservation

This paper reports the status and distribution of the Travancore tortoise, *Indotestudo forstenii* based on a field survey conducted in the Western Ghats of Karnataka, Kerala, and Tamil Nadu between 21 October and 30 December 1991. The survey identified strongholds of the Travancore tortoise and the several causes for its decline. The paper also describes tortoise habitat, morphometry, utilization by tribals and conservation problems.

INTRODUCTION

Indotestudo forstenii, commonly known as the Travancore tortoise is distributed in the semievergreen and evergreen forests of the Western Ghats, India. Two populations of this species have been established, one in Western Ghats and the other in Sulawesi Islands, Indonesia (Moll 1989). However, the latter population is considered to have been introduced from India and hence, this species should be considered as endemic to India. Groombridge (1982) classified this chelonian as 'insufficiently known' in the Red Data Book (1982) of the International Union for Conservation of Nature and natural resources (IUCN). It is included in the second category of the Action plan rating of IUCN which implies that this species is little known and has restricted distribution (Stubbs 1989). Published information on Travancore tortoise's natural history is scanty and cover only a few aspects such as: distribution, general biology (Smith 1931, Daniel 1983, Moll 1989) and taxonomy (Hoogmoed and Crumly 1984). This paper deals with the distribution, status, habitat, exploitation by tribals and conservation problems of Travancore tortoise.

METHODS

Study area: The study was carried out in the Western Ghats in the states of Karnataka, Tamil Nadu and Kerala from 21 October to 30 December 1991. Altogether, 11 protected areas were surveyed, namely three in Karnataka, four in Tamil Nadu and four in Kerala (Fig. 1). They are Neria Estate, Sharavati and Mookambika wildlife sanctuaries, in Karnataka; Mudumalai and Indira Gandhi (formerly Anaimalai) wildlife sanctuaries, Mundanthurai-Kalakad Tiger Reserve and Kothaiyar reserve forest in Tamil Nadu and Neyyar, Peppara Peechi-Vazhani and Parambikulam wildlife sanctuaries in Kerala.

Survey methods included searching in probable habitats and inquiring in tribal settlements and forest camps. The following measurements were taken using a dial vernier calipers: straight line carapace length (SCL), carapace width (CW), plastron length (PL) and shell height (SH). Live specimens were weighed (M) to the nearest gram using a spring balance. Also, information on forest type, micro habitat

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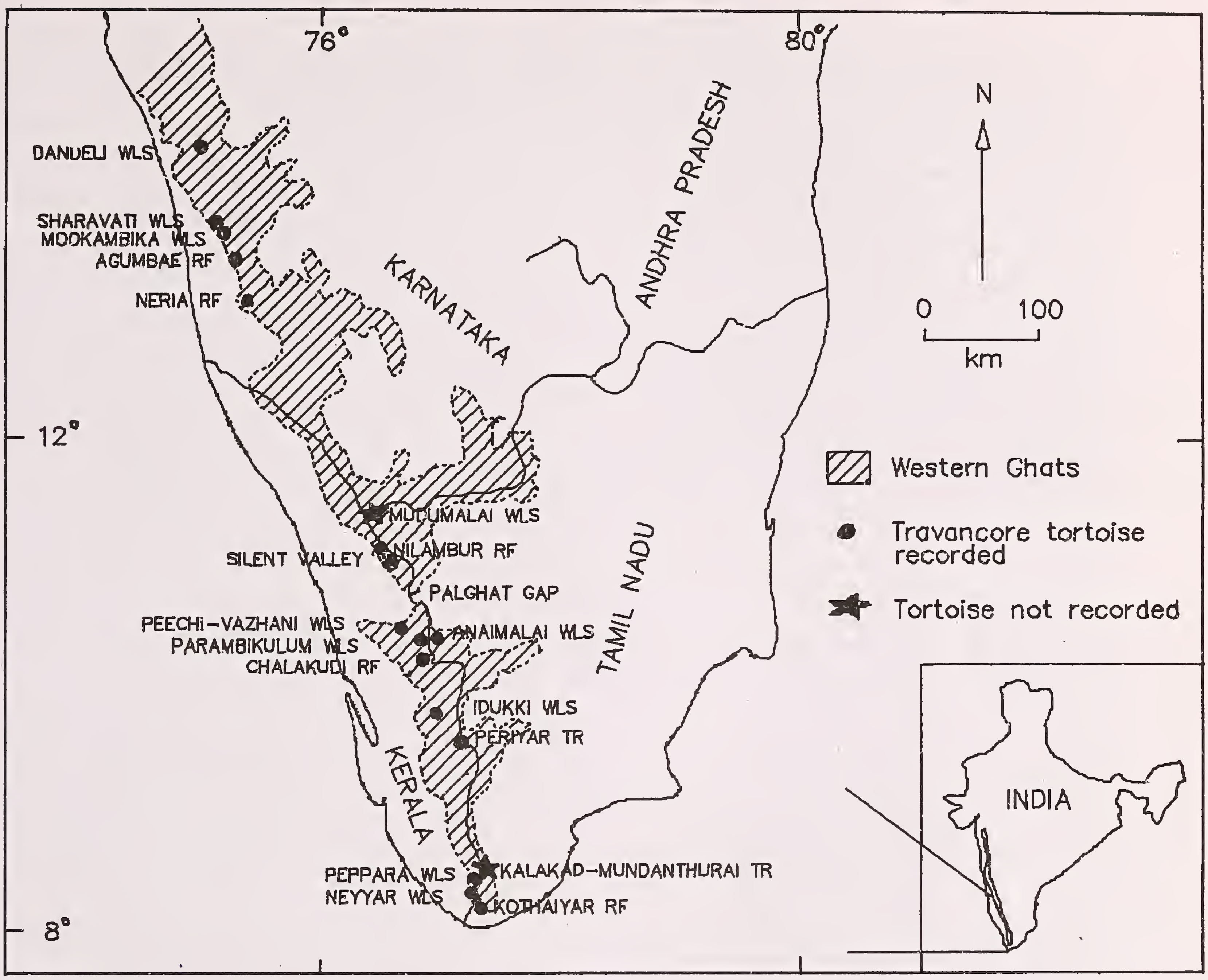
[1] Accepted June 1993.

[2] Salim Ali Centre for Ornithology and Natural History, Kalampalayam, Coimbatore, Tamil Nadu 641 010.

[3] Wildlife Institute of India, P.O. Box No. 18, Chandrabani, Dehra Dun 248 001. U.P.


76°
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DANDELI WLS
SHARAVATI WLS
MOOKAMBIKA WLS
AGUMBAE RF
NERIA RF
KARNATAKA
ANDHRA PRADESH
MUDUMALAI WLS
SILENT VALLEY
NILAMBUR RF
PALGHAT GAP
TAMIL NADU
PEECHI-VAZHANI WLS
PARAMBIKULUM WLS
CHALAKUDI RF
ANAIMALAI WLS
IDUKKI WLS
PERIYAR TR
KERALA
PEPPARA WLS
NEYYAR WLS
KALAKAD-MUNDANTHURAI TR
KOTHAIYAR RF
Western Ghats
Travancore tortoise recorded
Tortoise not recorded
INDIA

Fig. 1. Distribution of Travancore tortoise in the Western Ghats.

and elevation were noted.

Results and Discussion

Identity: The overall coloration of the Travancore tortoise is yellow with one black blotch on each scute of the carapace (Plate 1a) and plastron. Hatchlings and juveniles are brown and devoid of black markings. Skin around the eyes and nostril become pink during breeding season (Auffenburg 1964). The closest relative of the Travancore tortoise is the Elongated tortoise, *Indotestudo elongata* which is distributed in the sal (*Shorea robusta*) forests of the north and northeast India. The Travancore tortoise differs from Elongated tortoise in lacking the cervical (nuchal) shield and length of the interpectoral seam. The length of the interpectoral seam is shorter than the interhumeral seam in Travancore tortoise (Smith 1931). However, the lack of cervical shield is not always true as one individual was recorded with cervical shield during the present survey. This tortoise grows up to 33.1 cm

TABLE 1
KNOWN LOCALITY RECORDS OF TRAVANCORE TORTOISE IN WESTERN GHATS, INDIA

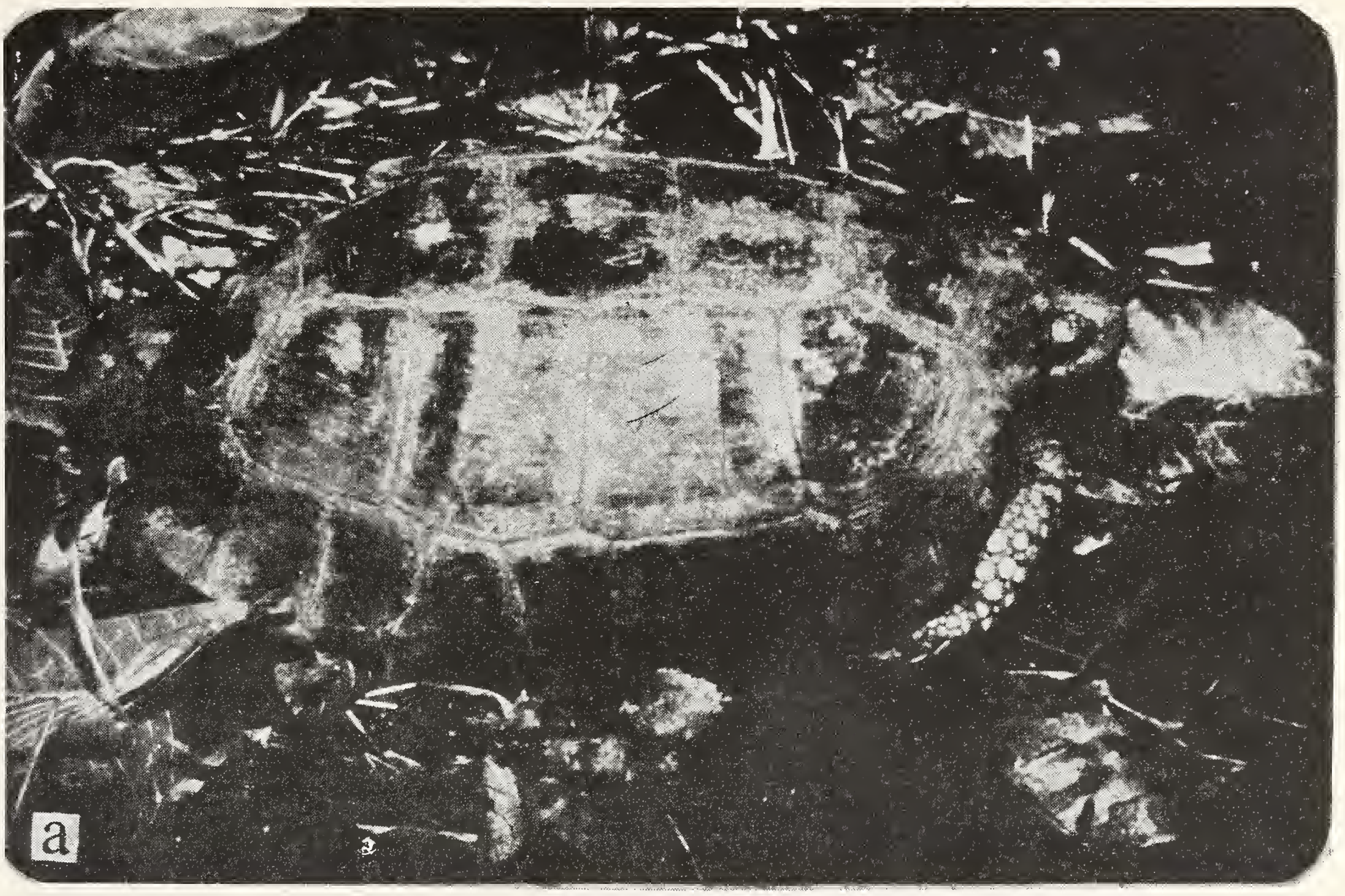
State	Locality	Source
Kerala	Neyyar Wildlife Sanctuary	Present survey
	Peppara Wildlife Sanctuary	Present survey
	Peechi Wildlife Sanctuary	Present survey
	Parambikulam Wildlife Sanctuary	Present survey
	Periyar Tiger Reserve	KFRI, Museum, Peechi
	Chalakudi Forests	Moll (1989)
	Silent Valley Wildlife Sanctuary	Karunakaran (1992, per. comm.)
	Karualai Reserve Forest	Nitin D. Rai (1992, per. comm.)
	Idukki Wildlife Sanctuary	Moll (1989)
Tamil Nadu	Kothaiyar Reserve Forest	Present survey
	Indira Gandhi Wildlife Sanctuary	Present survey
Karnataka	Neria Forest	Sharath (1990)
	Sharavati Wildlife Sanctuary	B.K. Sharath (1991, per. comm.)
	Mookambika Wildlife Sanctuary	B.K. Sharath (1991, per. comm.)
	Agumbae Forest	Das (1991)
	Dandeli wildlife sanctuary	Renee Borges (1991, per. comm.)

(Das 1991).

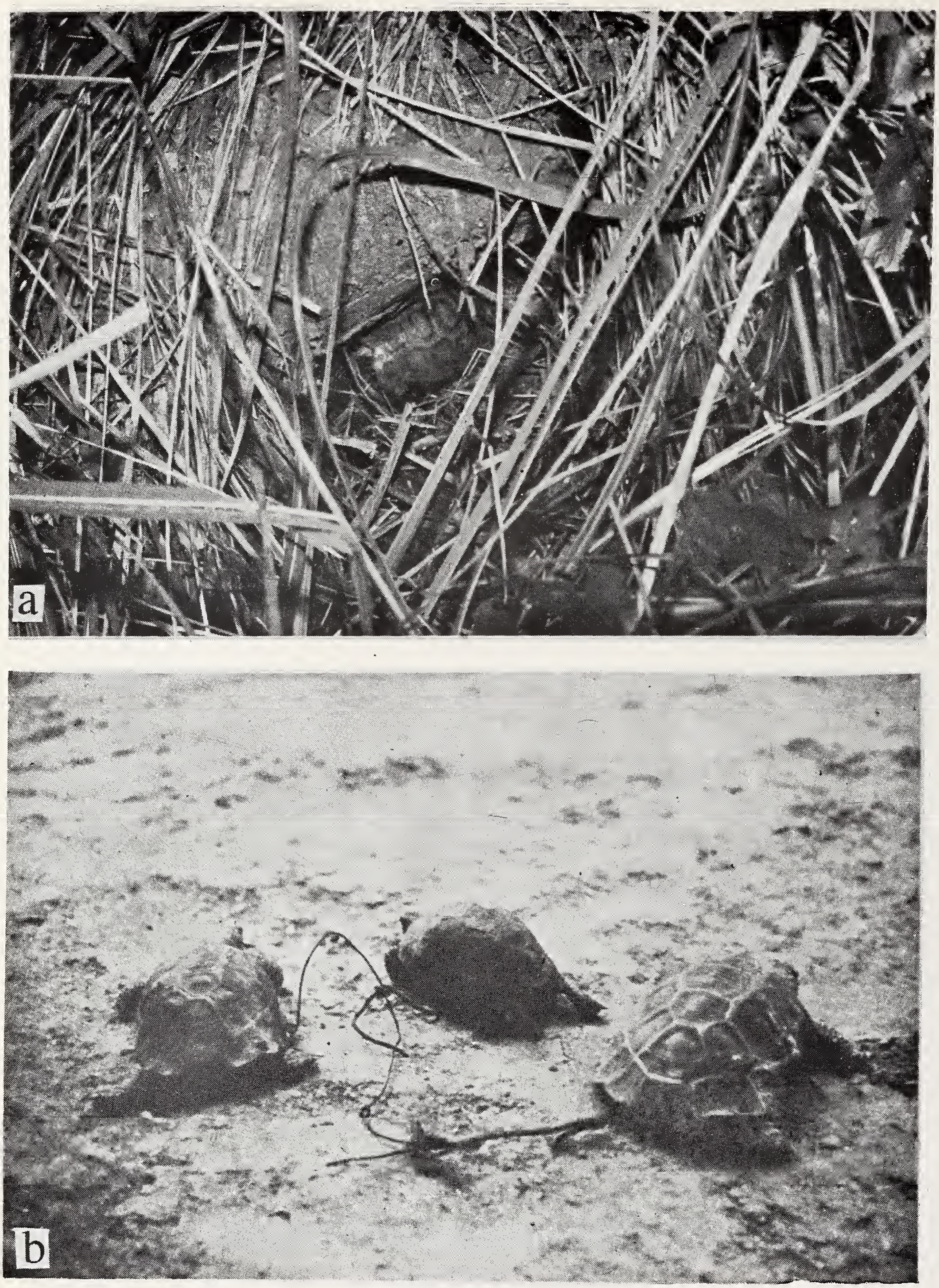
Distribution: Shells or live specimens of Travancore tortoise were recorded in six out of 11 localities surveyed (Fig. 1). They were, Neyyar, Peppara, Peechi-Vazhani and Parambikulam wildlife sanctuaries in Kerala and, Indira Gandhi wildlife sanctuary and Kothaiyar reserve forest in Tamil Nadu. Also, during the survey specimens collected from Neria forest, Sharavati and Mookambika wildlife sanctuaries in Karnataka by B.K. Sharath were examined.

The known distribution of this species is Travancore hills of Kerala and Coorg of Karnataka (Smith 1931, Daniel 1983, Moll 1989, Das 1991). Even though the distribution of this species is known as Travancore hills and Coorg, precise locality records are scanty. Additional records of this species are Kothaiyar reserve forest, Peppara, Neyyar and Peechi wildlife sanctuaries. Updated and precise information on the distribution of the Travancore tortoise are given in Table 1.

Status: In all, 32 Travancore tortoises were recorded during the present survey of which seven were seen live in the wild and, 17 live tortoises and eight shells were found in various tribal settlements and forest villages (Table 2). Approximately 17 to 31 hours were spent in actual searching for tortoises in wild and in tribal settlements in each locality surveyed. A maximum of 12 tortoises were recorded in Kothaiyar reserve forests and more than one tortoise in all localities except Indira Gandhi wildlife sanctuary. The number of live tortoises or shells obtained per man hour work during field surveys were 0.04 in Kothaiyar reserve forest and Peechi-Vazhani wildlife sanctuary and 0.07 in Parambikulam wildlife sanctuary (Table 2). Even though, no wild tortoises were recorded in Peppara and Neyyar wildlife sanctuaries, the number of specimens obtained in tribal settlements were high (7 and 4 tortoises respectively). Travancore tortoises are assumed to be uncommon in these areas. Moll (1989) found this tortoise to be common to Chalakudi forests, adjacent to Parambikulam wildlife



a. Travancore tortoise, *Indotestudo forstenii*. b. Moist deciduous forests of the southern Western Ghats. These forests still hold fairly good populations of the Travancore tortoise.



a. A close view of the diurnal retreat of Travancore tortoise. b. Tortoises kept by the *Kani* tribals of the Western Ghats for future utilization.

TABLE 2

STATUS OF TRAVANCORE TORTOISE IN SOME PROTECTED AREAS OF THE WESTERN GHATS

Details of information	Name of the Protected Areas					
	I	II	III	IV	V	VI
Tribal settlement survey						
No. of settlements checked	3	2	1	3	1	7
Man hours search time	10	10	1	3	1	15
No. of tortoise shells obtained	1	0	1	3	1	5
No. of live tortoises seen	7	4	0	1	0	5
Field survey						
No. of hours surveyed	8	8	16	20	20	16
No. of persons surveyed	3	3	3	3	3	3
No. of tortoises	0	0	2	3	-	2
Tortoise / man hour	-	-	0.04	0.07	-	0.04

Note: I. Peppara Wildlife Sanctuary; II. Neyyar Wildlife Sanctuary; III. Peechi-Vazhani Wildlife Sanctuary; IV. Parambikulam Wildlife Sanctuary; V. Indira Gandhi Wildlife Sanctuary; VI. Kothaiyar Wildlife Sanctuary.

sanctuary (0.175 tortoise/ man hour work).

The Travancore tortoise has been recorded in ten sanctuaries, one Tiger Reserve and five reserve forests. The occurrence of the Travancore tortoise in many other protected areas of western ridges of the Western Ghats is not ruled out. The Protected Areas (i.e. sanctuary, national park and tiger reserve) in which the Travancore tortoises have been recorded cover a total area of about 3900 sq. km in addition to six reserve forests. The ecological habitat of tortoise (i.e. habitat with actual distribution of the tortoise) such as evergreen or semievergreen and moist deciduous forests is very small. Hence, improved protection in Protected Areas would certainly help in the survival of this species.

Habitat: The Travancore tortoise was recorded in a variety of forest types such as, moist deciduous (Plate 1b), semievergreen and rubber plantations at elevations 100-800 m above sea level. The tortoise utilized rock crevices (burrows) at ground level, cavities in fallen trees (Plate 2a), leaf litter and bushes as diurnal retreats (Table 3). The tortoises recorded during the present survey were mostly near water, i.e. 5 - 200 m (Table 3).

TABLE 3

HABITAT DESCRIPTION OF TRAVANCORE TORTOISE BASED ON WILD CAUGHT TORTOISES

Locality	Habitat (forest type)	Micro-habitat	Elevation	Nearest water point
Kothaiyar RF	1. Rubber plantation	Leaf litter	100 m	200 m
	2. Moist deciduous	Fallen log	400 m	25 m
Peechi-Vazhani	3. Moist deciduous	Rock crevices	160 m	50 m
	4. Moist deciduous	Fallen log	400 m	1000 m
Parambikulam	5. Moist deciduous	Bush & fallen twigs	600 m	100 m
	6. Semievergreen	Bush	600 m	50 m
	7. Moist deciduous	Crevices	650 m	5 m

Morphometry: Seven tortoises were recorded in the wild and, 17 live tortoises and 8 shells in tribal settlements during the survey.

The largest specimen recorded was a female with SCL 270 mm and mass (M) 2600 gm (Table 4). It is a general belief that the number of rings on the carapace or plastral scutes of a turtle or tortoise are correlated with its age. SCL (size) and number of annular rings on the plastral/carapace scutes did not show a significant relationship ($r=0.365$, $p>0.05$, $n=23$). Hence, it appears that this belief is fallacious or it may be true for young tortoise up to approximately 10 years.

TABLE 4
MORPHOMETRY OF WILD-CAUGHT TRAVANCORE TORTOISES. MASS (M) IN GRAM (GM) AND OTHER MORPHOMETRY MEASUREMENTS IN MM

Survey locality	Sex	Morphometry			
		SCL	PL	CB	M
Kothaiyar RF	Male	235	182	136	1350
	Female	123	107	94	300
Peechi-Vazhani	Female	111	96	90	250
	Female	136	121	98	400
Parambikulam	Female	144	126	102	525
	Female	270	225	168	2600
	Female	118	103	92	300

Sex ratio: Over all, the population of the tortoise had a sex ratio of 1:5 (male: female, n=19). Of 32 shells and live tortoises recorded during the survey, 7 had an SCL less than 100 mm and were considered as juvenile and in another 6, only the carapace was obtained and hence sex was not ascertained. Available studies in western countries show that most tortoises have a sex ratio of 1:1 (Auffenburg and Iverson 1979). Information of the sex ratio is not available for Indian species. From this limited data, it may be stated that the sex ratio is skewed towards females in the Travancore tortoise.

Utilisation: Three major tribal communities were examined during the present survey: 1. *Kanis* or *Kanikaran* in Kothaiyar reserve forest, Neyyar and Peppara wildlife sanctuaries, 2. *Malayanmar* in Peechi-Vazhani wildlife sanctuary and 3. *Kadars* in Parambikulam and Indira Gandhi wildlife sanctuaries. All used tortoises as pets, food, and medicine. *Kanis* call this tortoise 'vengala ama' (=brass turtle) or 'kal ama' (=stone turtle), whereas *Malayanmar* and *Kadars* used the name 'chural ama' (=cane turtle). Among the tribals of the surveyed Western Ghats, the *Kanis* utilised the Travancore tortoise most extensively. They keep them as pets by drilling a hole in one of the posterior marginals, at times tying three or more tortoises together on with a string (Plate 2b). They also use powder of the charred shell mixed with oil as a cure for external injuries and rashes. The tribals believe that the blood and meat of the tortoise cure stomach ailments, ulcers and piles. The consumption of tortoises as food by *Kadar* and *Hill Pandaram* tribals of the Western Ghats has already been reported (Moll 1989).

Conservation: Habitat destruction by timber operations, cane collection and exploitation by tribals are some of the factors causing the present rarity and sparse distribution of this species. In almost all Travancore tortoise areas, hydroelectric projects or reservoirs were recorded causing habitat alteration and fragmentation.

The Travancore tortoise is listed as 'vulnerable' in IUCN Red Data Book, whereas it is included only in the Schedule IV of the Indian Wildlife Protection Act 1972. Even though Travancore tortoises are common in some areas, considering the fast disappearing evergreen and semievergreen forests and anthropogenic pressure, and being an endemic to the Western Ghats, additional legal protection is recommended.

The capture of tortoises by tribals should be controlled. Legal and illegal operations such as timber cutting, cane and honey collection should be checked in tortoise habitat. The loss of evergreen and semievergreen forests from developmental projects within the Travancore tortoise's distribution range should be reviewed. Studies on various aspects of ecology of this turtle is urgently needed. This would help not only in scientific management of the Protected Areas, but will also help in the continued survival of this species.

ACKNOWLEDGEMENTS

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ON THE MORPHOLOGY, ADVERTISING CALL AND HABITAT OF THE BUSH FROG *PHILAUTUS LEUCORHINUS* (LICHTENSTEIN AND MARTENS, 1856)[1]

ALOYSIUS G. SEKAR[2]

(*With a text-figure*)

Key words: *Philautus leucorhinus*, morphometry, call sequence, habitat

The information on the morphometry and ecology of the Bush frog *Philautus leucorhinus* (Lichtenstein and Martens, 1856) is meagre. The species was studied for their mating call and the habitat, in Goa during the monsoon in 1989. A total of 24 individuals were collected to study morphometry. Statistical relationship between different morphometric parameters was analysed. There was significant positive correlation between Snout-Vent length and Tibia length. The time taken for call sequence was also analysed. The individuals of the Bush frog used various microhabitats of shrubs while making their mating call.

INTRODUCTION

The genus *Philautus* (Family Rhacophoridae: Amphibia) comprises of small robust frogs which are usually 2-3 cm in snout-vent length. Species of this genus live in shrubs and low vegetation in tropical rain forest, sometimes quite far from water (Liem 1970). They appear only in the monsoon season. Due to their elusiveness information on their morphometry and ecology is meagre. Some Indian species of this genus have been described by Boulenger (1890) and Inger *et al.* (1984) with very little morphometric details. McCann (1932) provided some details on the call and habitat of species *Philautus bombayensis*. However, the literature on this group is negligible. In 1989 about 24 adult males of *Philautus leucorhinus* were collected from Goa forests (Volpoi-15, Molem-6 and Canacona-3) during the monsoon. This species has been recorded in India from Goa, Karnataka and Kerala states along the Western Ghats (Sekar 1991). This paper describes the morphology, statistical relationship between the morphometric parameters, advertising call and habitat of the bush frog *Philautus leucorhinus*.

MATERIALS AND METHODS

The frogs were collected from shrubs when they were making advertising call at night. They were preserved in 10% formalin. About 24 adult males were preserved. The call was recorded with the help of a micro cassette recorder. To measure the morphometric characters a dial vernier (least count 0.05 mm) was used. Some of the morphometric variables were compared with each other. Statistical analysis such as correlation coefficient (r) and regression equation ($Y=mX + C$) were done.

RESULTS

Morphology: (a) *Diagnosis:* Small sized frog; adult male measured up to 29.45 mm in snout to vent length, average 26.96 mm (Table 1). Snout pointed projecting beyond the mouth. Nostrils nearer to tip of the snout than the eye. Tympanum distinct, almost half the diameter of the eye. Interorbital space broader than the width of upper eyelid. First finger shorter than second; fingers with a slight rudiment of web. Toes 2/3

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[1] Accepted September 1993.

[2] Bombay Natural History Society, Hornbill House, Dr. Salim Ali Chowk, Shaheed Bhagat Singh Marg, Bombay 400 023.

TABLE 1

THE MEASUREMENTS (IN MM) OF 24 ADULT MALES OF *Philautus leucorhinus* COLLECTED FROM GOA

Measurements	Range	Mean	S.D. ±	Ratio of measurement to SV length (%)
Snout-Vent length	24.30-29.45	26.96	1.18	-
Head length	8.30-10.85	9.29	0.52	34.45
Head width	9.50-11.40	10.13	0.49	37.56
Internasal space	2.30-3.10	2.69	0.23	9.97
Interorbital space	2.90-3.80	3.48	0.27	12.90
Width of upper eyelid	2.30-3.20	2.62	0.19	9.71
Diameter of eye	3.25-4.00	3.63	0.21	13.46
Tympanum	1.60-2.10	1.92	0.16	7.12
Arm length	11.40-16.40	14.24	0.93	52.80
Diameter of lower arm	2.40-3.05	2.68	0.22	9.94
Hand length	7.70-9.60	8.54	0.40	31.66
Leg length	37.30-47.00	40.63	2.12	150.65
Tibia length	11.90-15.25	13.07	0.74	48.50
Length of foot & tarsus	12.40-19.95	17.36	1.38	64.37
Foot length	10.00-12.25	11.12	0.55	41.23
Inner metatarsal tubercle	0.80-1.10	0.98	0.07	3.63
Width of toe-pad	1.30-1.80	1.57	0.13	5.82
First finger length	2.00-3.10	2.56	0.27	9,49
Second finger length	3.25-3.95	3.58	0.20	13.27

webbed. Tips of fingers and toes dilated into disc; the disc with circum-marginal groove. Tibio-tarsal articulation reaches tympanum or posterior border of the eye. Heels touch each other when legs are folded at right angles to the body. Sub-articular tubercles of fingers and toes moderate. Inner metatarsal tubercle small and prominent.

Skin smooth above; a raised median line from the tip of the snout to the vent; belly, under side of thigh and around vent granular; a fold from the eye to the shoulder.

(b) *Colour:* The upper surface was light brown. A dark band below the canthus rostralis

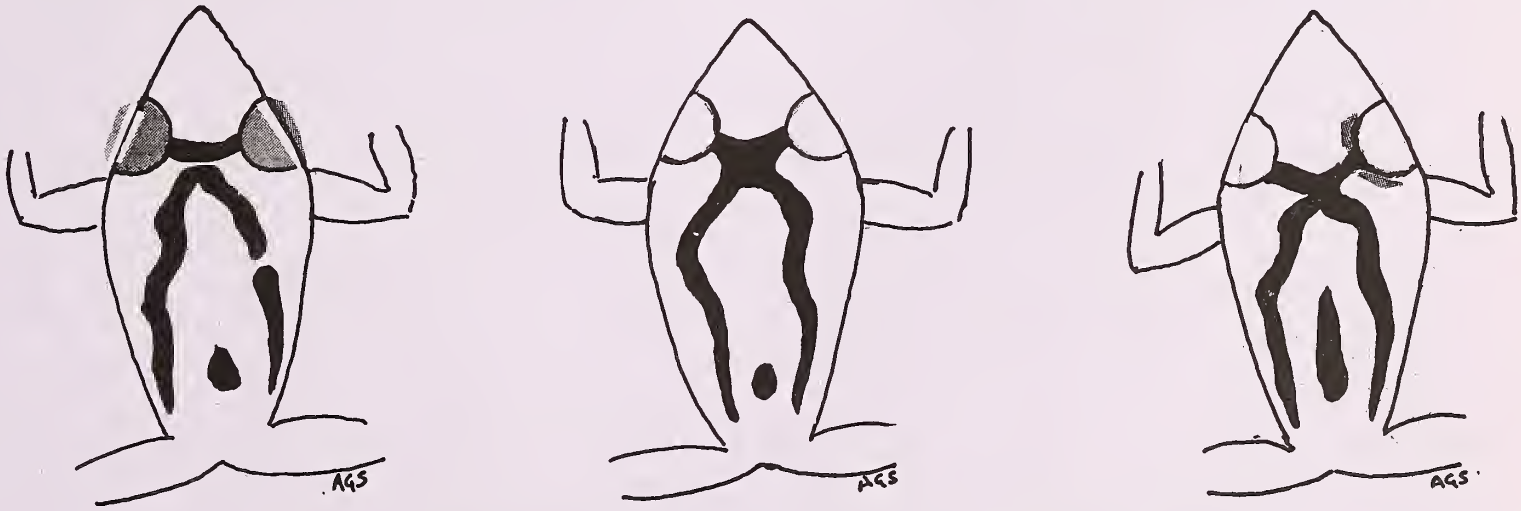

Fig. 1. Dorsal side of *Philautus leucorhinus* with different markings.

and on the temporal region. The upper eyelids and the interorbital width darker than the body. An arch, one on each side of the back, joined at interorbital width varies in the pattern (Fig. 1). Arms in forelimbs, femur and thighs in hindlimbs are barred. Throat dotted with brown.

TABLE 2

STATISTICAL RELATIONSHIP BETWEEN DIFFERENT MORPHOMETRIC PARAMETERS IN *Philautus leucorhinus* (N=24, df=2)

Morphometric parameters	r value	t value	Significance	Regression equation
SV length (X) with Tibia length (Y)	0.80	6.25	P<0.001	Y=0.5X-0.1
Tibia length (X) with foot length (Y)	0.728	4.9771	P<0.001	Y=0.98X-1.68
Diameter of eye (X) with diameter of Tympanum (Y)	0.59	3.4161	P<0.01	Y=0.45X+0.29
Head width (X) with interorbital space (Y)	0.457	2.4109	P<0.05	Y=0.25X+0.95
Head length (X) with foot length (Y)	0.39	1.9881	P<0.1*	Y=0.4X+7.1
SV length (X) with Head length (Y)	0.37	1.8861	P<0.1*	Y=0.16X+4.98

* Not significant

(c) *Morphometric relationship:* Morphometric measurements such as snout-vent length (SV length), tibia length, head length, foot length, diameter of eye, diameter of tympanum, head width and interorbital space were taken and the relationships between these parameters were analysed statistically. Results of analysis (Table 2) indicated that there was significant positive correlation between SV length and Tibia length ($r=0.8$, $P<0.001$), Tibia length and foot length ($r=0.728$, $P<0.001$) and diameter of eye and diameter of tympanum ($r=0.59$, $P<0.01$) whereas the positive correlation between head length and foot length, and SV length and head length are not significant at $P<0.1$ level.

Advertising call: The advertising or breeding call of this species was recorded and studied. The frogs occupied different parts of the shrubs from which they relayed their call. They sat on the stems, branches and leaves in various positions, including the snout towards land and sticking upside down on the back of the leaves. Some of them were located inside curled dry leaves and also small cavities in the stems. Males have a single vocal sac which was like a bubble when it was fully inflated. Though the call is usually heard in chorus, the call of individuals was also recorded.

The call can be syllabilized as *'trek....trek....trek...trekkkkktak tak tak'*. This makes one call sequence. To find out the average time taken for a call sequence, 10 sequences were observed. The time ranged from 8.64 to 43.74 seconds. On an average, each call sequence lasts for 21.41 seconds (Table 3). The duration of the sequence was dependent on number of '*trek*' made by the frog during the call. The frog remained silent after it vocalised each '*trek*'. The time interval between the two '*trek*' calls was calculated from 25

TABLE 3

DATA ON THE TIME (IN SECONDS) TAKEN FOR A CALL SEQUENCE (N=10) AND TIME INTERVAL BETWEEN TWO '*TREK*' IN A SEQUENCE (N=25)

Call	Range	Mean	S.D. ±
Time taken for call sequence	8.64-43.74	21.41	8.79
Time interval between two '*treks*' in a sequence	2.33-5.39	3.62	0.82

observations.The frog remained silent for 3.62 seconds on an average after each '*trek*' in the sequence. They were very wary of intruders. They stop calling even at the slightest movement or disturbance.

Habitat: All the frogs were collected from shrubs of 2-3 m height in the moist deciduous forests and also in non-forested areas with shrubs. They were seen sitting on stem, branches on and under the leaves. No specimen was seen on the ground. They were collected far from the water. All frogs were caught guided by their call, so there was no female in the collection.

DISCUSSION

The adult male frogs averaged 26.96 mm in snout-vent length. Boulenger (1890) recorded the length as 33 mm (1.3 inches) and Kirtisinghe (1957) has recorded it as 31 mm from specimens collected in Sri Lanka. But none of them mentioned the sex of the frog. The female may be a little larger in size than the male. Inger *et al.* (1984) have recorded the females as bigger than the males in all *Philautus* species collected by them at Ponmudi. The relationship between the different morphological measurements of *Philautus leucorhinus* was found to be positive especially the SV length and tibia length. Tibia length and foot length shows a high positive correlation.

The pattern of the call is totally different from that of its related species *Philautus bombayensis* which can be syllabilised a '*tik tik tik*'. The observation on the frogs calling sitting in face down position is supported by McCann's (1932) observation on *Philautus bombayensis.* He described that being a tree frog this species generally rests on the bark of trees and bush in facing down position. In this position the large vocal sac is inflated to its maximum. All frogs were picked up from shrubs and none from the ground. Inger *et al.* (1984) have described the habitat of some related species *P. charius, P. femoralis, P. signatus* and *P. temporalis.* Among these species only *P. femoralis* was collected only from shrubs, the specimens of other species were collected from various microhabitats such as shrubs, on the surface of dead leaves on the ground, beneath logs, on the bare soil surface and on rocks. Though the frogs were seen calling, their breeding behaviour and egg laying behaviour are yet to be studied.

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MATING BEHAVIOUR OF THE INDIAN GREY MONGOOSE *HERPESTES EDWARDSII EDWARDSII* GEOFFROY[1]

JAGATHPALA SHETTY, GUNAPALA SHETTY AND S.R. KANAKARAJ[2]

(*With a text-figure*)

Key words: Mongoose, mating behaviour

A study of copulatory behaviour of the grey mongoose *Herpestes edwardsii edwardsii*, was made in captivity on 5 adult mongooses consisting of 2 males and 3 females. Both true and false mountings were recorded, in which the mountings occurred between the members of same sex or opposite sex. In the latter case, mounting between a dominant male and a dominant female usually resulted in true mounting and it lasted from 50 to 150 sec. The maximum frequency of mounting between a dominant male and a dominant female coincided with the oestrus of the female. The general pattern of mounting observed is compared with other species of mongooses. The role of heterosexual mounting in sexual orientation in their social behaviour is discussed.

INTRODUCTION

The courtship and mating behaviour has a close correlation with the social habit of animals and their social integration. In carnivores, generally pairing is not a temporary affair, in which sexually motivated individuals meet, copulate and part. In some cases it is a prelude to a partnership in which the male as well as the female will have parental responsibilities lasting till the young become self-supporting. Among viverrids the reproductive behaviour has been described in a relatively few species, which show that there is considerable diversity within the family (Ewer 1973). The members of herpestinae, a subfamily under Viverridae, comprising exclusively of mongooses, have received moderate attention with respect to their reproductive behaviour and parental care and the investigations are restricted to observations in captivity (Ducker 1960, Zannier 1965, Neal 1970, Ewer 1973, Rasa 1973a, b, 1977; Rood 1980, Jacobsen 1982). However there is no scientific data available on the mating behaviour of Indian Grey mongoose *Herpestes edwardsii edwardsii*. In this paper we have made a comprehensive study on the reproductive behaviour of grey mongoose in captivity.

MATERIALS AND METHODS

The grey mongooses used in the study consisted of 5 adult individuals: 2 males and 3 females captured in semiurban surroundings around the city of Mysore. The animals were housed in 4 cages with movable partition each measuring 90 cm x 45 cm x 45 cm which were serially connected with a free passage in between. The food provided once a day in the morning included beef liver, chicken heads, rats and mice often supplemented with chicken eggs taking care to see that each animal received sumptuous amount of food approximately ¼ of its body weight. Water was provided *ad libitum*.

The individuals were kept together for about 3 months before the commencement of observation for mating behaviour during which time a social hierarchy became established. The observations were for an average duration of 3 hours per day for about 50 days. Most of the

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[1] Accepted June 1994.

[2] Department of Studies in Zoology, University of Mysore, Manasagangotri, Mysore 570 006, Karnataka.

observations were made from behind a black curtain with peep holes in front of the cages. Simultaneously the reproductive status of the females was also determined everyday by the examination of the vaginal smear collected by restraining the animal using movable partition of the cage.

Table 1a
FREQUENCY OF MOUNTING OBSERVED IN A GROUP OF 5 MONGOOSES

Mounting individual	Mounted individual				
	♂1	♂2	♀1	♀2	♀3
♂1	-	15	178	10	12
♂2	0	-	15	12	18
♀1	25	20	-	5	2
♀2	0	8	0	-	6
♀3	0	5	7	0	-

Table 1b
MEASURES OF COPULATORY BEHAVIOUR OBSERVED IN A PAIR OF DOMINANT ADULT MONGOOSES

Total mounts	178
Mating with ejaculation	16
Percentage of mating with ejaculation	8.98
Mean number of intromissions to ejaculate (M ± S.E.)	18.44± 0.848
Mean duration of time (in secs) of a mount with ejaculation (M ± S.E.)	103.47± 3.997

The frequency with which each individual of the group mounted one another is given in Table 1a, in the form of a matrix. Table 1b gives the measurements of copulatory behaviour recorded for a pair of dominant mongooses. The licking of genitals by both partners following the break of copulation was taken as a criterion for a true and complete copulation (Rasa 1977).

Observations and Discussions

Two categories of mounting were distinguished: (a) 'False mounting' was observed to occur between the members of the same sex or opposite sex. It was characterised by the non-occurrence of premounting rituals; (b) Mounting between a dominant male and a dominant female usually resulted in true mounting. The occurrence of mounting was more ritualistic and far more frequent between a dominant male and a dominant female compared to the mountings occurring between subordinate individuals. The maximum frequency of the mounting between a pair of dominant individuals coincided with the oestrus of the female (Fig. 1A). A pronounced friendly interaction was also noticed between the partners during this period. They remained in contact, slept together and groomed each other more frequently.

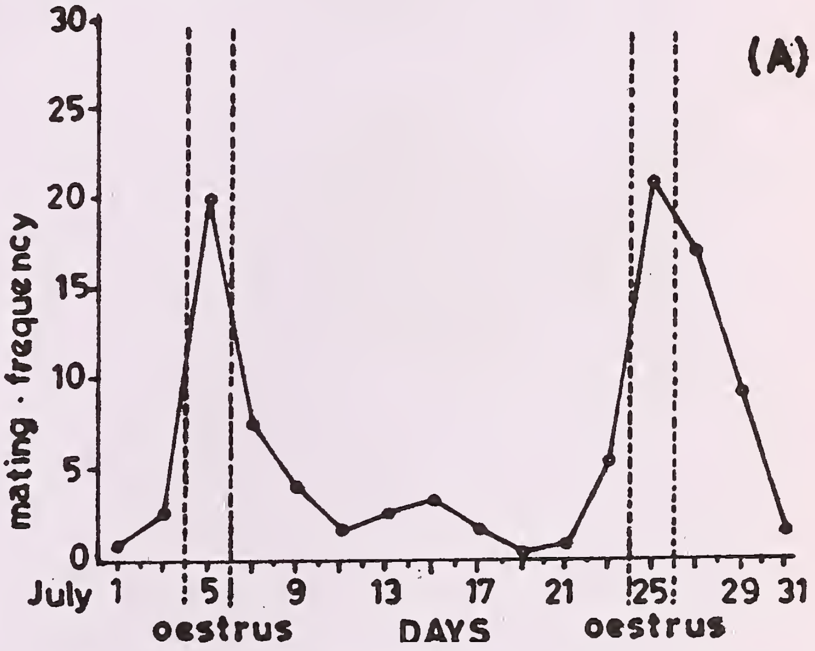

Fig. 1A. Frequency of mounting on an adult dominant pair of mongooses during oestrus of the female.

The oestrus female which was maximally receptive responded to an investigating male by not moving away. The preliminary investigatory activity by the male included sniffing and smelling of the snout and anogenital region of the female. When the male mounted from the posterior side by clasping the sides of the female with its forelimbs the female attained a receptive posture by arching its back slightly and moving her tail aside (Fig. 1B, i). The male clasped the

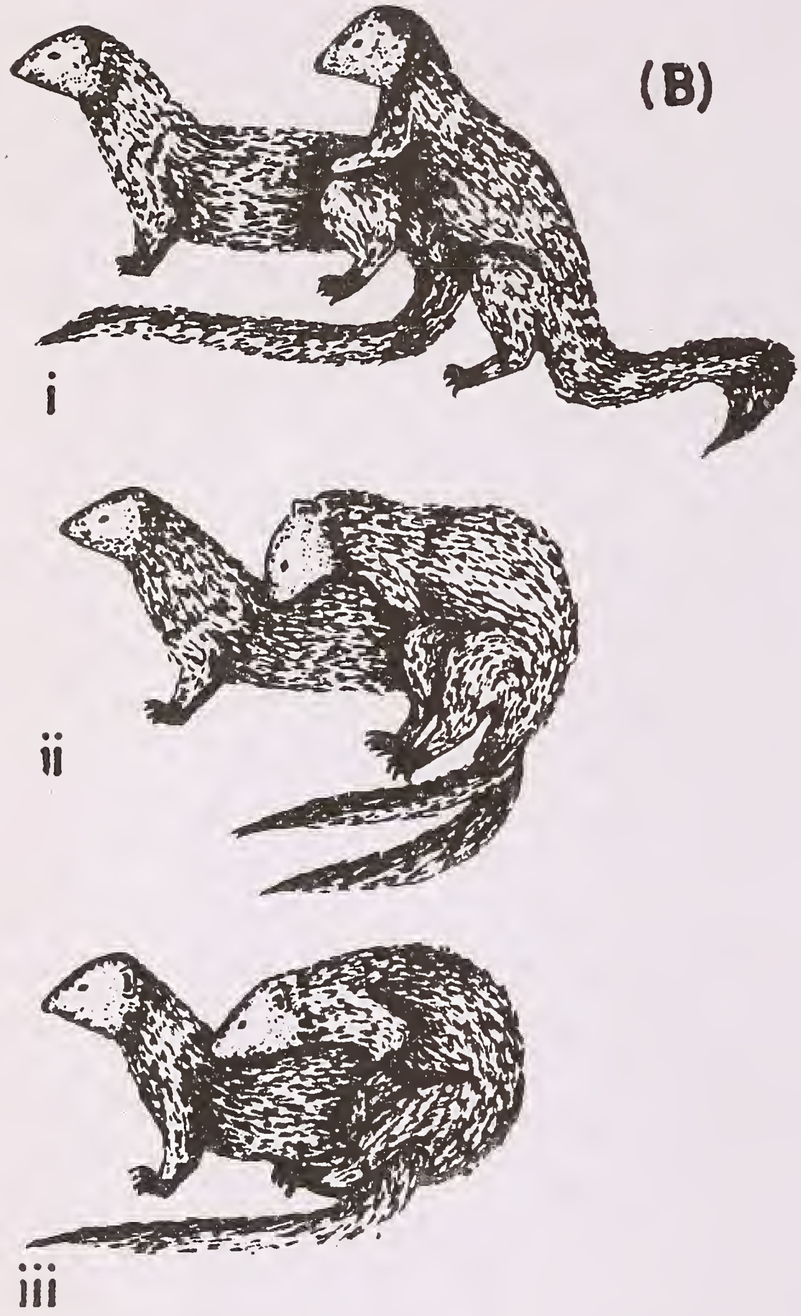

Fig. 1B. Postures adopted by a pair of mongooses during different stages of mounting.
(i) Preliminary stage of mounting by a male with a reciprocating female. (ii) Intermediate stage of mounting with the male holding the female and beginning the intromissions. (iii) Final stage of intromission. Note the position of chin of the male and the hind-legs which are raised from the floor.

flank of the female and intromission followed (Fig. 1B, ii). Towards the end of the process the male flexed one or both the hind limbs and lifted them off the floor and placed its chin pressed against the side and neck of the female (Fig. 1B, iii). Soon after the copulation the partners parted company, sat on their hind limbs and licked their genitals. This behaviour was however not observed at the end of all mountings. A true mounting beginning with the rapid thrusts and ending with the ejaculatory thrusts lasted from 50-150 secs. The male was found not to be successful in mounting in all its attempts. This was more evident in case of mounting involving the subordinate male. In such instances the female moved away in the midst of the process which sometimes dislodged the male.

Of the total mountings occurring between the members of highest rank 8.98% of the mountings resulted in ejaculation. The dominant male always preferred to mount the dominant female. Among false mountings 76.68% were heterosexual and 23.31% were homosexual. The Mann-Whitney 'U' -test showed that in a group the tendency for heterosexual mounting is more compared to homosexual mounting ($P < 0.1$).

The general pattern of mounting observed in captive grey mongoose is similar to what has been reported in other mongooses like *Herpestes ichneumon* (Ducker 1960), *Helogale parvula* (Zannier 1965, Rasa 1973, Rood 1980), *Mungos mungo* (Neal 1970), *Herpestes sanguineus* (Jacobsen 1982) and *Helogale undulata rufula* (Rasa 1977). In all these mongooses there is more or less uniform short preliminary premounting sessions. The increased marking behaviour during the oestrus of the female reported in *Crossarchus* (Ewer 1973) and *Helogale undulata rufula* (Rasa 1977) was not observed in the present study. However the oestrus of the female was marked by a high frequency of mounting as reported in dwarf mongooses (Rasa 1977). The grey mongooses also differ from meerkats (Ewer 1973) in not showing the typical 'neck-gripping' - a means of inducing passivity in a recalcitrant female. Lacking a neck grip and the manner in which the male thrusts its head against the female's neck as observed in the grey mongoose have also been reported in *Herpestes* and *Mungos* (Ewer 1973).

The short premounting rituals among the captive group may be attributed to a high social organisation. Due to prior familiarity between the partners in a captive social group, there appears to be no need for prolonged preliminaries leading to establishment of contact. The act of mounting does not seem to inflict any rivalry between individuals. Neal (1970) has made a similar observation in *Mungos mungo*. In the present case it may be due to the fact that the observations are confined to a socially stabilised group where definite hierarchy had been established. Less frequent occurrence of mating between subordinate individuals may also be due to the same reason. Occurrence of homosexual mountings has also been reported in *Helogale undulata rufula* (Rasa 1973a, 1976) and *Helogale parvula* (Rasa 1973b). In the grey mongooses though both homo- and heterosexual mountings have been recorded, the higher frequency of the heterosexual mounting suggests that mounting is sexually oriented.

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COMPOSITION, ABUNDANCE AND DISTRIBUTION OF FISH IN BANGANGA-GAMBHIR RIVER SYSTEM AND SOURCE OF FISH TO THE KEOLADEO NATIONAL PARK, BHARATPUR[1]

C.R Ajith Kumar[2] N.K. Ramachandran[3] and Arun Asthana[4]

(*With two text-figures*)

Key words: Banganga-Gambhir river, *Notopterus chitala*, *Labeo dyochilus*, *Lepidocephalichthys guntea*, *Danio devario*, *Aplocheilus panchax*, *Labeo boggut*, geomorphology

The Keoladeo National Park, Bharatpur is situated at the confluence of two non-perennial rivers Gambhir and Banganga. A detailed survey of the ichthyofauna was carried out in the river course and in the tributaries of these rivers to know the composition, abundance and distribution of fish. Every year Keoladeo National Park gets water as well as millions of fry from these rivers and the piscivorous birds mainly depend upon this fry input. The study showed that, even though both the rivers are non-perennial, Gambhir has a number of perennial pools in the river course and also in the tributaries. Conservation of these perennial pools is very essential to get sufficient fish fry to the Park. In spite of that, several bunds are constructed and they are extensively used for reservoir fisheries. The perennial pools and the reservoirs are the main source of fry to the Park.

During the survey, samples were collected from 27 sites from Banganga-Gambhir river system and another three from Chambal. A total of 46 species were recorded, out of which 41 species were recorded from Banganga-Gambhir river system. Compared to Banganga, more species were recorded from Gambhir. It may be due to the direct connection of this river with Yamuna. Further analysis of the data from Gambhir showed that half of the species were uniformly distributed and the other half were site specific, which include the rare species also. The rarest species were *Notopterus chitala*, *Labeo dyochilus*, *Lepidocephalichthys guntea*, *Pseudeutropis atherinoides*, *Danio devario*, etc. *Aplocheilus panchax* and *Labeo boggut* were only recorded from Banganga. Air-breathing fishes were also recorded during the collection; however, their number was very less.

Introduction

Keoladeo National Park, Bharatpur supports more than 40 species of piscivorous birds which are recorded in thousands during the peak season. Apart from the birds, terrapins, otters and fishing cats also consume a portion of the fish. To support these high trophic level species, a large quantity of fish is required every year. Yearly, millions of fry (as many as 65 million in 1985, Vijayan 1986) and adults of small size fish or larval fish (e.g. *Oxygaster clupeoides*, *Chanda nama* and *Puntius sophore*) enter the park along with the inflowing water. The recruitment of fry showed that all the non-airbreathers enter the Park from outside; this constitutes a major portion of the total fish population in the Park (Kumar 1991). Therefore, the outside source of fish is vital for the proper functioning of the park ecosystem. The breeding of all the fish-eating birds depends on the timely arrival of fish from outside. An examination of he source of fish was therefore undertaken.

The Park receives water from Ajan bund, a temporary reservoir situated 500 m from the Park's border. And the Ajan bund in turn

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[1] Accepted June 1994.

[2] Bombay Natural History Society, Hornbill House, Dr. Salim Ali Chowk, Shaheed Bhagat Singh Marg, Bombay 400 023.

[3] Salim Ali Centre for Ornithology and Natural History, Kalampalayam P.O., Coimbatore 641 010.

[4] Department of Zoology, D.A.V. College, Kanpur.

receives water mainly from the two non-perennial rivers Gambhir and Banganga. As these rivers dry up every year, the following questions arise:

1. Where does the fish stock remain when the rivers dry up? or where do fish breed to provide fry to the park during monsoon?
2. What is the nature of distribution of fishes along the river course?
3. Is there any similarity between the fish fauna of the river and that of the Park?

To tackle these questions, an exhaustive survey was carried out during May-June 1989. Both the rivers were covered from their origin to the termination point.

METHODOLOGY

Samples were collected from the water bodies in the river course as well as their tributaries including the dams and bunds. Collections were carried out using cast net of smallest mesh size (15 mm) and seine of mosquito net of 40 metre length and 1.5 metre height with floats and sinkers. Fish samples were also collected from commercial catch in the reservoirs done under the control of Fisheries Department.

A uniform catch effort was maintained to minimise bias. The various collection points are shown in Fig. 1.

RESULTS AND DISCUSSION

Gambhir river: This non-perennial river originates from Karauli hills of Sawai Madhopur district and after flowing 280 km in Rajasthan, ultimately joins river Yamuna in U.P. The river bed is clayey, alluvial and deep. There are deep ravines, especially upstream near Hindon and also where it joins Yamuna near Fathehabad.

The largest dam right across the river is Panchna near Karauli, where five small rivers unite to form Gambhir. A number of small and medium-sized dams have been constructed across the tributaries of Gambhir such as Urmila Sagar bund, Bund Bareta, Parvati dam, Bhandua and Jagar. These bunds are extensively used for reservoir fisheries by the State Fisheries Department. Every year the department introduces major carp seed and auctions them in summer.

On its course, Gambhir often takes zig-zag turns so that deep pools are formed where fishes can survive in summer. One of the tributaries of Gambhir, Parvati, has a very long perennial water stretch up to the river Gambhir. According to the villagers, this water stretch does not dry up even in severe drought years. During the survey, we recorded deep water bodies, both lentic and lotic, in the river.

At Sevala Bareta, an obstruction has been constructed with sluice gates to block the water and direct it to Ajan bund through Pichuna canal. During heavy flood, water overflows the dam towards Yamuna.

The first series of collections were carried out along the course of river Gambhir.

Banganga: This is also a non-perennial river originating from Manoharpur near Ramgarh of Aravalli range in Jaipur district. This river is much wider, very sandy and without any ravines. In some places it is just a sandy depression and one can hardly make out the river course. After flowing 241 km in Jaipur and Bharatpur districts, it terminates at Maghpur head and from there canals supply water to the nearby areas, and one of them, Uchain canal, joins Ajan bund.

The biggest dam across this river is Jamwa Ramgarh near Jaipur and the smaller dams on the tributaries are Kalako, Bhandari and Senthal.

Aravalli, one of the oldest mountain ranges of the subcontinent and once the highest range,

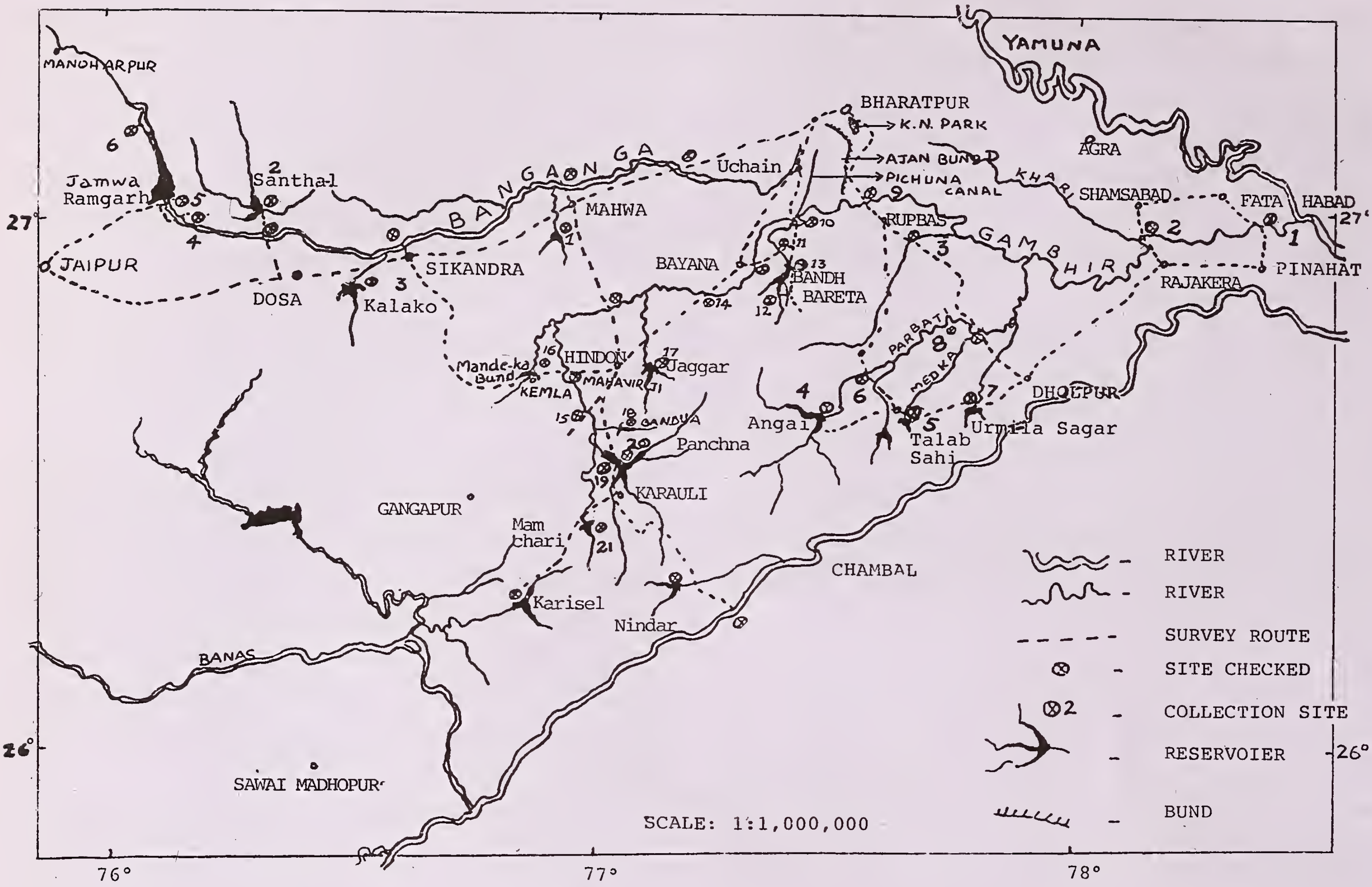
YAMUNA
MANOHARPUR
BHARATPUR
K.N. PARK
AJAN BUND
PICHUNA CANAL
AGRA
Jamwa Ramgarh
Santhal
BANGANGA
Uchain
MAHWA
KHARI
SHAMSABAD
FATA HABAD
RUPBAS
GAMBHIR
PINAHAT
RAJAKERA
JAIPUR
SIKANDRA
BAYANA
BANDH BARETA
DOSA
Kalako
Mande-ka Bund
HINDON
MAHAVIRJI
KEMLA
Jaggar
PARBATI
MEDKA
DHOLPUR
GANDUA
Angai
Talab Sahi
Urmila Sagar
Panchna
KARAULI
GANGAPUR
Mam chari
CHAMBAL
Karisel
Nindar
BANAS
SAWAI MADHOPUR
SCALE: 1:1,000,000
RIVER
RIVER
SURVEY ROUTE
SITE CHECKED
COLLECTION SITE
RESERVOIER
BUND
27°
26°
76°
77°
78°

Fig. 1. Map showing the various sampling stations in the Banganga and Gambhir river system.

at earlier times would have blocked the monsoon clouds much more effectively than it does today to make the Banganga, a mighty river and it might have been connected either with Yamuna or Gambhir in geological time. The Gangetic plain rivers often change their courses and due to this, the river might have passed through the depression of the Keoladeo National Park.

Geomorphological study with the help of landsat imagery and aerial photographs of Gambhir river basin reveals the fluvial changes that have occurred during the quaternary period. The river Gambhir was once a major right bank tributary of the river Banganga which in turn was a major right bank tributary of Yamuna (Sharma 1986). Further detailed investigations by Sharma (1986) along the middle and lower course of river Banganga and Gambhir show that in the recent past Banganga was a continuous stream flowing up to the Yamuna. But because of neotectonic activity around Bharatpur, the flow of Banganga river has been obstructed and now it is neither directly connected with Yamuna nor with Gambhir. Banganga is a mountain torrent with a bed of sand mixed with gravel in a semi-arid climatic condition. It, therefore, brings tremendous quantity of sediments from headwaters to the plains. In due course it got choked and became braided with a number of distributaries in this part of the land area. The neotectonic activity was re-activated on one hand and tremendous quantity of sediments was deposited on the other hand, causing a saucer-shaped depression in Bharatpur region (Sharma 1986), and, this depression in Bharatpur is inadequate to allow a free flow of the river Banganga to join the river Yamuna. So during the period of high rainfall the area gets flooded. To control the flood and also to make use of water for agriculture, a skillful network of bunds was constructed several decades ago. The water thus contained by the dykes is gradually drained off and the land is used for raising the kharif crop. This system of irrigation is known as inundation irrigation (Anon. 1979). Ajan bund is considered to be the oldest such bund constructed somewhere between 1726-1763 (Gasquin 1927, Panday 1970). In early times, the water management was under the control of local rulers. Nowadays the Irrigation Department governs the distribution of water and supplies it to the park from Ajan bund.

The flat sandy nature of the river bed, the anthropogenic interferences as well as degradation of Aravalli might have contributed in many ways to erase the actual river course.

SURVEY DISCUSSION

During the survey, a total of 46 species of fish were recorded of which four species were from Chambal and one from a dam connected with the Chambal. They are *Barilius bola, Chagunius chagunius, Labeo boga* and *Puntius dorsalis* from Chambal and *Garra gotyla* from Needad dam. *Puntius dorsalis,* collected during the survey from Chambal was the first recorded by Datta Gupta *et al.* (1961) from Khetry, Jaipur or Udaipur. The exact place of the catch was not mentioned. It is included in the list of Datta and Majumdar (1970) and the subsequent faunal studies in Rajasthan (Dhawan 1969, Mathur and Yazdani 1970, 1973; Mahajan 1980, Sharma and Kulshreshtha 1981, Johal and Dhillon 1981, Sharma and Johal 1982, Johal and sharma 1986, Gupta *et al.* 1988) did not mention this species. According to Jayaram (1981), it is a peninsular species.

Another important species recorded during the survey was *N. chitala* from Gambhir, just before its confluence with Yamuna in Uttar Pradesh. The only earlier record of this species was from Ajan bund near Bharatpur by Moona (1963). It is considered to be an endangered species (Menon 1987).

New addition to the fish fauna of Rajasthan: *Aplocheilus panchax* recorded from Banganga during the survey was a new addition to the fish fauna of Rajasthan. Even though this fish has a wide distribution in South Asia (Jayaram 1981), there was no record of this species from Rajasthan (Kumar and Asthana 1993). During this survey it was very frequently seen in Ramgarh area, upstream as well as downstream. *A. blochii* was recorded from Jodhpur by Mathur and Yazdani (1969).

Species richness and distribution of fishes in the rivers: Out of the total 46 species collected during the survey, 38 were recorded from Gambhir and 28 from Banganga (Tables 1 and 2). Connection of Gambhir with Yamuna may be one of the reasons for the higher richness of species in Gambhir than in Banganga. However, three species, namely *Aplocheilus panchax*, *Labeo boggut*, and *Channa striatus* were not observed in Gambhir.

Gambhir: Further analysis of the catch from the river Gambhir was carried out using SYSTAT software and a dendrogram was prepared (Fig. 2). An arbitrary line was drawn in the middle. The result shows that half of the species were distributed uniformly and these species were recorded in large numbers (Table 1 - e.g. *Cirrhinus reba, Labeo rohita, Puntius sophore, Osteobrama cotio, Salmostoma bacaila*, etc.). The other half were comparatively rare and site specific. Some of them were recorded mostly upstream, such as *Danio devario*, *Labeo*

TABLE 1
COLLECTION SITES AND SPECIES RECORDED IN GAMBHIR RIVER AND ITS TRIBUTARIES

	Sampling sites																				
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Gudusia chapra	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-	-	-
Notopterus chitala	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Notopterus notopterus	1	1	3	-	-	1	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-
Chela cachius	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-
Salmostoma bacaila	-	2	-	2	-	-	-	3	-	2	-	-	-	3	2	2	-	-	3	-	2
Salmostoma phulo	-	2	-	-	-	-	-	2	-	-	-	-	-	2	2	2	-	-	3	-	2
Esomus danricus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Danio devario	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Amblypharyngodon mola	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
Puntius sarana	-	-	-	1	-	-	-	-	-	-	-	1	2	1	1	-	-	1	-	-	1
Puntius sophore	2	2	3	2	-	-	3	3	-	2	2	2	-	2	2	3	2	1	-	2	2
Puntius ticto	1	1	-	-	-	-	-	2	-	1	-	-	-	-	1	-	-	-	-	-	2
Osteobrama cotio	3	3	3	3	-	3	-	-	3	2	-	3	-	-	2	-	-	-	-	2	-
Labeo bata	-	-	-	-	-	-	1	-	-	-	2	-	-	-	2	-	-	3	1	-	2
Labeo calbasu	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	1
Labeo dyocheilus	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Labeo gonius	-	-	-	1	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	1
Labeo pangusia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-
Labeo rohita	2	2	-	3	-	-	-	2	2	1	-	2	2	-	1	-	2	2	2	2	3
Cirrhinus mrigala	2	2	-	3	-	2	2	-	2	-	-	-	-	1	2	-	2	3	2	2	2

Table 1 (*continued*)

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Sampling sites																				
Cirrhinus reba	3	3	3	3	-	-	-	2	3	2	2	3	3	2	3	-	3	-	-	2	2
Catla catla	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	-	2
Noemacheilus botia	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Lepidocephalichthys guntea	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Mystus cavasius	-	-	1	-	-	2	-	-	1	2	1	-	-	-	1	-	-	-	-	1	-
Mystus vittatus	1	1	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Mystus seenghala	-	-	-	3	-	2	-	-	-	-	-	-	-	-	-	-	2	-	2	-	2
Ompok bimaculatus	-	1	1	-	-	1	1	-	-	-	-	3	2	3	-	-	-	-	-	-	1
Wallogo attu	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Pseudeutropius antherinoides	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Heteropneustes fossilis	-	-	-	-	2	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-
Xenentodon cancila	-	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Channa marulius	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channa punctatus	1	-	-	1	2	-	1	1	-	-	-	-	-	-	-	3	-	-	-	-	-
Chanda nama	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	-
Chanda ranga	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
Glossogobius giuris	2	-	-	2	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-	-
Mastacembelus armatus	-	1	-	2	-	-	1	-	-	1	-	2	-	-	1	-	1	-	1	-	1
Total species	12	13	7	16	4	6	8	10	6	10	7	9	6	11	13	6	7	7	12	9	18

- absent 1 = rare 2 = common 3 = dominant

Site 1: Gambhir just before joining with Yamuna; Site 2: Gambhir river (next to the point where the tributary Khari joins Gambhir); Site 3: River Kagwar; Site 4: Parvati or Angai dam; Site 5: Talab Sahi; Site 6: 15 km away from Sepu in Parvati river; Site 7: Urmila Sagar; Site 8: Second site in river Parvati; Site 9: 5 km before Rubas; Site 10: Sevala Bareta; Site 11: Near Supa bridge (Kakund nadi 10 km from Bareta dam); Site 12: Dar (upstream of Bareta); Site 13: Bund Bareta; Site 14: Samovar bridge (between Bayana and Hindon); Site 15: Katkar; Site 16: Mandai-ka-Bund; Site 17: Jagar Bund; Site 18: Bandua Bund (Jagar to Karouli) 17 km to Karouli; Site 19: Panchna dam; Site 20: Near Panchna bridge; Site 21:Mamchari Bund (13 km south-west of Karouli).

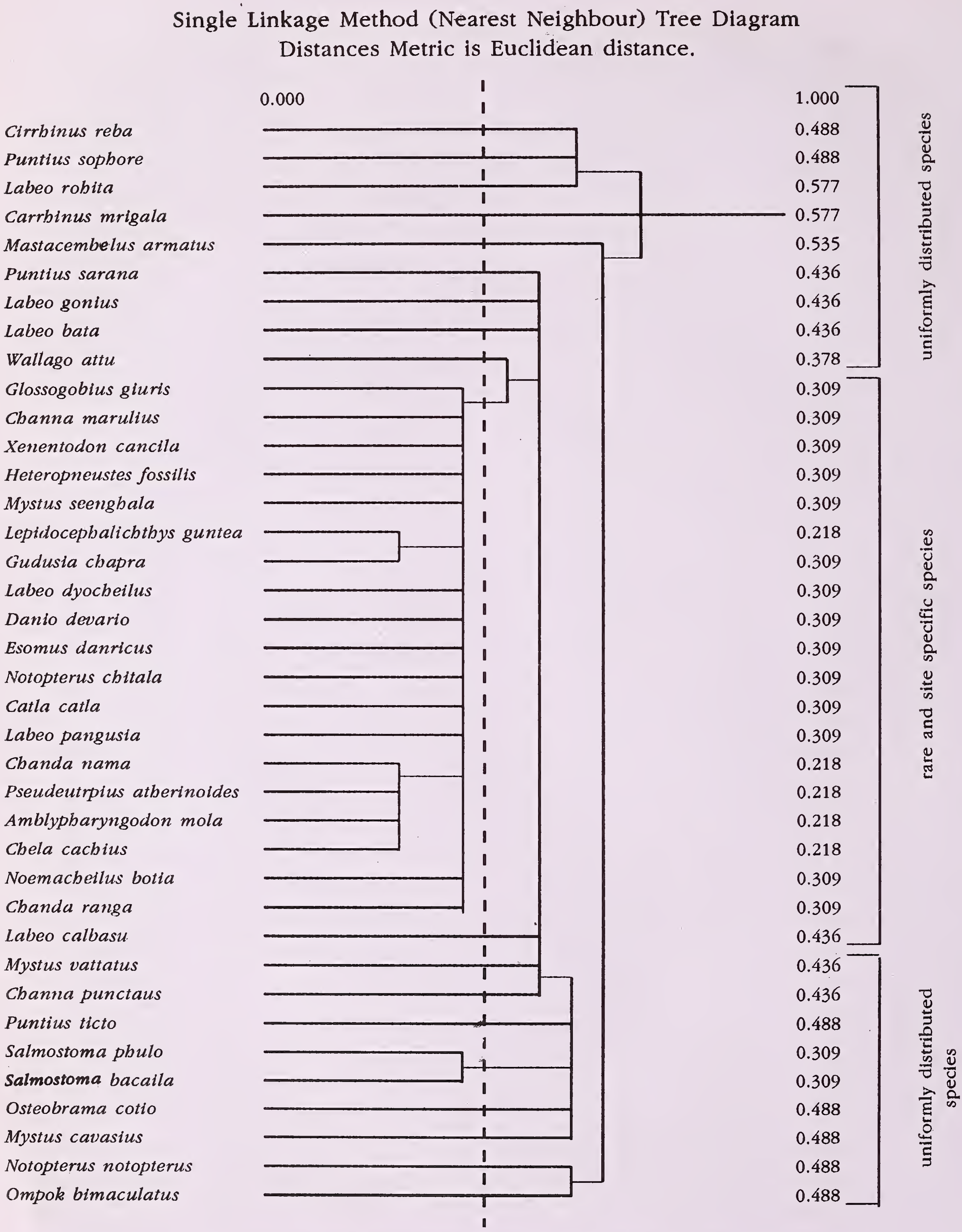

Fig. 2. Dendrogram showing the two main groups of species in Gambhir river.

TABLE 2
COLLECTION SITES AND SPECIES RECORDED IN BANGANGA RIVER AND ITS TRIBUTARIES

Species	Sampling sites					
	1	2	3	4	5	6
Notopterus notopterus	-	1	1	-	-	-
Salmostoma bacaila	2	-	3	-	-	-
Salmostoma phulo	2	-	3	-	-	-
Esomus danricus	-	-	-	3	-	-
Danio devario	-	-	-	-	2	-
Amblypharyngodon mola	-	3	3	-	-	2
Puntius sarana	1	1	-	-	-	-
Puntius sophore	-	-	-	2	2	3
Puntius ticto	-	-	-	2	-	2
Osteobrama cotio	3	3	2	-	-	-
Labeo bata	-	-	-	2	2	-
Labeo calbasu	1	1	1	-	1	-
Labeo rohita	2	-	-	-	-	-
Cirrhinus mrigala	2	2	-	-	2	-
Cirrhinus reba	2	2	2	3	2	-
Catla catla	-	2	-	-	-	-
Mystus cavasius	-	1	-	-	-	-
Mystus vittatus	-	-	-	1	1	-
Mystus seenghala	-	1	-	-	-	-
Ompok bimaculatus	-	1	-	-	1	-
Wallago attu	-	1	-	-	-	-
Channa marulius	-	1	-	-	-	-
Channa punctatus	1	1	-	1	1	-
Channna striatus	1	-	-	-	-	-
Glossogobius giuris	1	-	-	-	-	-
Mastacembelus armatus	1	3	-	-	-	-
Aplocheilus panchax	-	-	-	-	2	2
Labeo boggut	-	-	-	-	1	-
Total species	12	15	7	7	11	4
	*	*	*		*	

- = absent 1 = rare 2 = common 3 = dominant * = dam

Site 1: Bhandari bund; Site 2 : Senthal bund; Site 3: Kalako bund; Site 4: Downstream of Banganga; Site 5: Jamva Ramgarh; Site 6: Upstream of Ramgarh

pangusia, Chela cachius, Catla catla and *Esomus danricus.* Some other species such as *N. chitala, Guducia chapra, Xenentodon cancilla, Channa marulius*, etc. were downstream specific.

The most dominant recruiting species to the Park, such as *Puntius sophore, Cirrhinus reba, Salmostoma bacaila (Oxygaster bacaila)* and *Osteobrama cotio* recorded during the survey had a wide distribution in the river course. Major carps such as *Cirrhinus mrigala* and *Labeo rohita* also had a wide distribution because of their introduction to reservoirs for commercial purpose. These widely distributed species enter the Park in large numbers when water is drawn from these sources. *Chanda*, one of the major species that enters the Park, was confined to Panchna and Angai dams. It can, therefore, be concluded that the origin of most of the non-airbreathing species inside the Park is these dams and the pools in the river course. Because of large quantity of water present in reservoirs, more species were recorded in them particularly in Angai, Panchna and Mamchari, but in some reservoirs water depth was very low and so was the number of species.

Banganga: The river Banganga is not directly connected with Yamuna which may be one of the reasons for the fewer number of species in this river (Table 1). Yet another reason may be its possible sandy nature. During the flood period, indirect connection is possible through the flood water and also through the Ajan bund which is connected with both the rivers- Banganga and Gambhir. There was no perennial water body in the river course except a small stretch near Ramgarh and a pool upstream of Ramgarh. So the recruitment of fry from this river is only from the reservoirs.

Aplocheilus panchax, which was a new addition to the fish fauna of Rajasthan was restricted only to Ramgarh area. Among *Labeo* species *Labeo boggut* was recorded only from Ramgarh area and not from Gambhir. The species such as *Gudusia chapra, Notopterus* sp., *Chela cachius, Labeo dyocheilus, Labeo gonius, Labeo pungusia, Noemacheilus botia, Lepidocephalichthys guntea, Pseudeutropius atherinoides, Heteropneustes fossilis, Xenentodon cancila*, and *Chanda* spp. were not recorded from river Banganga.

Fish stock: A large number of small and large dams have been constructed across the tributaries of both Banganga and Gambhir for irrigation as well as for drinking water. Almost all these dams are used for reservoir fisheries by the State Fisheries Department. Major carps are being introduced in these reservoirs every year by the Department.

In addition to the perennial reservoirs, a number of deep pools and small stretches of water are present on the course of river Gambhir and the river bed is more alluvial. Important among them (upstream to Bharatpur) are near Sevla Bareta, Supa bridge, Samover bridge and at Katkar. Downstream to Bharatpur are collection site 6 and 8 in Parvati and 9, 2 and 1 in the river course of Gambhir. These pools provide habitat for the fish stock to survive the summer and breed during the monsoon. Almost all fishes, mainly the small ones, captured in these pools were in breeding stage. Conservation of these perennial pools is very essential to get sufficient fish fry to the Park.

In the reservoirs, small as well as large commercial species were abundant. In some reservoirs autostocking is also reported. When water is released from these reservoirs the fishes get into the river and disperse. Hence these pools and reservoirs are the main source of fish to the Ajan bund and thereby to the Park. Another possible source is that when Gambhir joins Yamuna during high discharge, there is a chance of upstream movement of fishes to Gambhir because of the tendency of fish to move against the current.

Several species which were not reported from the Park were collected during the survey such as *Labeo pungucia, L. dyocheilus, L. boggut, Notopterus notopterus* and *Aplocheilus panchax* (Kumar and Vijayan 1988), although their number was very low. Such rarity may be one of the reasons for the non-availability of these fishes and their fry in the Park.

Even though there are air-breathing fishes in some of the reservoirs such as Angai dam, Talab sahi, Urmila sagar, and Manda-ka-bund, they are very rare in the river course. Air breathers are not riverine species.

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KEY TO THE INDIAN SPECIES OF THE GENERA *ORTHRIUS* GORHAM AND *XENORTHRIUS* GORHAM (COLEOPTERA: CLERIDAE: CLERINAE)[1]

JONATHAN R. MAWDSLEY[2]

Key words: Coleoptera, Cleridae, *Orthrius*, *Xenorthrius*

Dichotomous keys are provided for the identification of the 17 species of the genus *Orthrius* Gorham and the 5 species of the genus *Xenorthrius* Gorham known from India. *Orthrius stevensi* Corporaal is synonymised with *Orthrius binotatus* (Fisher), New synonymy.

INTRODUCTION

The genera *Orthrius* Gorham and *Xenorthrius* Gorham presently contain 58 and 14 species, respectively, and are generally distributed throughout the Indo-Australian region. Both *Orthrius* and *Xenorthrius* belong to a large group of genera in the subfamily Clerinae of the family Cleridae in which the eyes are coarsely granulate (facet diameter 0.30 mm or greater). At present, 22 genera are included in this group (Corporaal 1950: 97-127). However, the limits of these genera are poorly-defined, and further research will probably reduce the number of genera recognised in this group through synonymy. At the present time, I do not think that the single character given above is sufficient justification for erecting a tribe for the species of this group, as this character is strongly correlated with nocturnal habits and hence is probably highly convergent.

Orthrius and *Xenorthrius* both belong to a section of this generic group in which the elytra are more or less robust and the elytral punctures are relatively small. Separation of genera in this group is particularly problematic, and it seems probable that the African genera *Gyponyx* Gorham and *Aphelochroa* Quedenfeldt will eventually have to be placed in synonymy with *Orthrius*.

The only other genus of this group which is found in India is *Opilo* Latreille, which is presently under review by other workers. Species of *Orthrius* and *Xenorthrius* may be separated from species of *Opilo* by examination of the terminal segment of the maxillary palpi, which is triangular in *Opilo* but cylindrical in *Orthrius* and *Xenorthrius*. Species of *Orthrius* and *Xenorthrius* may be separated by means of the key given below. Complete bibliographic information for all species may be found in Corporaal (1950: 123-126).

MATERIALS AND METHODS

I have examined specimens of the species of these genera from the collections of the following institutions: The Natural History Museum, London; Hope Department of Entomology, Oxford University; Institut Royal des Sciences Naturelles de Belgique; Museo Civico di Storia Naturale, Genova; Museum of Comparative Zoology, Harvard University; Museum National d'Histoire Naturelle, Paris. In all cases, I have based my identifications of species on personal examination of original type specimens. Distributions of species of these genera are poorly known at present, and it is hoped that the present paper stimulates interest in this neglected field of clerid research.

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[1] Accepted October 1993.

[2] Department of Entomology, Museum of Comparative Zoology, Harvard University, Cambridge, MA 02138, USA

KEY FOR SEPARATION OF *Orthrius* AND *Xenorthrius*

1. Pronotum deeply and rugulosely punctate laterally, almost strigose; elytral punctures separated by small tubercles .... Genus *Xenorthrius* Gorham
Pronotum finely and sparsely punctate laterally, smooth, shining; elytral punctures not as above ... . Genus *Orthrius* Gorham

Genus *Orthrius* Gorham

Orthrius Gorham (1876: 74; 1892: 737); Schenkling (1903: 29, 45); Chapin (1924: 208, 211); Corporaal (1950: 123-126).

Type-species *Orthrius cylindricus* Gorham (by orginal designation).

KEY TO INDIAN SPECIES OF *Orthrius* GORHAM

1. Elytra distinctly striatopunctate, at least at base . 2
- Elytra finely punctate at base, shining 12
2. Pronotum with two or three distinct tubercles .. 3
- Pronotum lacking such tubercles 4
3. Pronotum bituberculate; elytra uniformly reddish-brown. ...... *Orthrius tuberculicollis* Schenkling
- Pronotum tritubercualte; elytra with two yellow maculae .... *Orthrius dorsalis* Schenkling
4. Elytra uniformly reddish-brown, in one species with a single pair of black median maculae 5
- Elytra yellowish-brown or black 8
5. Legs entirely reddish-brown .... *Orthrius rufotestaceus* Schenkling
- Legs at least in part black 6
6. Legs and abdomen entirely black .... *Orthrius tarsalis* Gorham
- Legs and abdomen in part reddish-brown 7
7. Elytral punctures becoming irregular by apical third .... *Orthrius striatopunctatus* Schenkling
- Elytral punctures in rows from base to apices .... *Orthrius brachialis* Gorham
8. Elytra robust, wider than pronotum 9
- Elytra elongate, as wide as pronotum 10
9. Elytra black with three yellowish-white maculae which attain suture .... *Orthrius subsimilis* White
- Elytra black with two yellowish-white maculae which do not attain suture *Orthrius abdominalis* (Germar)
10. Each elytron yellowish-brown with three black maculae ...... *Orthrius sexplagiatus* Schenkling
- Each elytron yellowish-brown with two black maculae 11
11. Pronotum very dark brownish-black .... *Orthrius sufasciatus* (Westwood)
- Pronotum yellowish-brown .... *Orthrius bengalus* (Westwood)
12. Elytra yellow with brown maculae 13
- Elytra reddish-brown with white maculae 15
13. Each elytron largely yellow, with a single black apical macula .... *Orthrius posticalis* (Westwood)
- Elytra not as above 14
14. Elytra laterally brownish-black, yellow along the suture .... *Orthrius elongatus* Corporaal
- Elytra predominantly brownish-black with two transverse yellow maculae .... *Orthrius binotatus* (Fisher)
15. Elytra bimaculate ... *Orthrius madurensis* Gorham
- Elytra trimaculate 16
16. Ground colour of elytra distinctly paler in colour than that of pronotum .... *Orthrius grandjeani* Pic
- Ground colour of elytra and pronotum concolorous.. .... *Orthrius feae* Gorham

Genus *Xenorthrius* Gorham

Xenorthrius Gorham (1892: 733; 1893: 575); Schenkling (1903: 29, 46); Corporaal (1950: 126).

Type-species *Xenorthrius mouhoti* Gorham (by original designation).

KEY TO INDIAN SPECIES OF *Xenorthrius* GORHAM

1. Elytral apices rounded 2
- Elytral apices truncate, bidentate .... *Xenorthrius truncatus* Gorham
2. Elytra brown with yellowish-white maculae ... 3
- Elytra uniformly reddish-brown 4
3. Elytra with two transverse white maculae narrowly joined along the suture; apices black .... *Xenorthrius mouhoti* Gorham
- Elytra with two transverse white maculae not joined along suture; apices white .... *Xenorthrius ephippiatus* Gorham
4. Length/width ratio of elytra greater than 3.0:1.0 .. .. *Xenorthrius robustus* Corporaal
- Length/width ratio of elytra equal to or less than 3.0:1.0 .... *Xenorthrius geniculatus* Gorham

DISCUSSION OF NEW SYNONYMY

I have examined a large number of

specimens of *Orthrius binotatus* (Fisher) collected throughout the range of this species (India east to China and south to New Guinea). In general, the coloration of this species is very variable, but the surface sculpturing is not. The specimens from India described as *Orthrius stevensi* by Corporaal (1926: 180-181) and preserved in the Natural History Museum, London, fall within the range of both colour and sculptural variation of *Orthrius binotatus,* and on the basis of this evidence I have no difficulties in synonymising *Orthrius stevensi* Corporaal with the previously-described species *Orthrius binotatus* (Fisher), New synonymy.

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TAXONOMIC STUDIES OF THE SPECIES OF *HOLOTHURIA* (LINNAEUS, 1767) FROM THE SEAS AROUND INDIA[1]

Part 1

D.B. JAMES[2]

(*With a plate and two text-figures*)

Key words: *Holothuria,* taxonomy, habits, habitats, Andaman and Nicobar Islands, Gulf of Mannar, Palk Bay, Lakskadweep

In this paper earlier attempts made to revise the genus *Holothuria* Linnaeus, 1767 are given in detail. Of the 26 species known under the genus *Holothuria* from Indian seas, 18 species have been collected by me. These have been described in detail with full synonymy, notes on habits and remarks with figures and photographs. Keys have been provided for all the species known from Indian seas.

INTRODUCTION

The genus *Holothuria* Linnaeus, 1767 has been subject for revision since the early part of this century. A large number of holothurians have been assigned to this genus and it became very unwieldy to handle and arrange the species correctly. In order to sort out this problem, various attempts have been made in the past to revise the genus. Rowe (1969) considered that the number of valid species under the genus was about 114.

REVIEW OF EARLIER CLASSIFICATIONS

Pearson (1913-1914) attempted to revise the genus *Holothuria*, based on material from the Indian Ocean. He divided the genus *Holothuria* into five subgenera, namely *Bohadschia* Jaeger, *Actinopyga* Bronn, and included three new subgenera *Argiodia, Halodeima* and *Thymiosycia.* He was of the opinion that by the elaboration of the simple branched rods and rosettes of the species *Actinopyga* and *Bohadschia*, perforated plates, and later, buttons and tables could have developed. He considered that the calcareous ring of *Actinopyga* and *Bohadschia* are primitive since they lack the anterior and posterior projections and have deep ampullar notches. In the genera *Argiodia, Halodeima* and *Thymiosycia,* the radial and interradial plates of the calcareous ring show marked projections. The radial plates are also markedly longer than the interradial plates. He did not give much taxonomic importance to the presence or absence of anal 'teeth' or papillae. He was of the view that the arrangement of the tubefeet in *Actinopyga* and *Bohadschia* also showed that they are more primitive than his three new genera. Pearson (1913, 1914a, b) dealt only with a few species from the Indian Ocean, so his revision was incomplete.

Panning (1929-35) did an admirable job by bringing all the information on the genus *Holothuria* together, but, according to Deichmann (1958), this magnificent work suffered from his dependence in too many cases on the accounts of earlier workers; hence many errors have been perpetuated and related forms have been placed far apart. In his revision of *Holothuria*, he treated *Actinopyga, Bohadschia* and *Microthele* as subgenera. Later, Panning (1939) revised his treatment of *Holothuria.* He

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[1] Accepted October 1992.

[2] Central Marine Fisheries Research Institute, Kochi 682 031. Present Address: Tuticorin Research Centre of CMFRI, 90 North Beach Road, Tuticorin 628 001.

was not sure of the relationship between *Actinopyga* and *Bohadschia* since he did not consider the presence or absence of anal papillae to be of great importance, but he concluded that there could be no relationship between *Actinopyga* and *Microthele*, the possession of anal papillae in both being the result of convergence.

Deichmann (1958) felt that the name *Holothuria* Linnaeus (i.e. *sensu* 1758) should be discarded and the species previously included in it divided into a number of genera. She proposed 13 generic names, of which 11 were new to science. According to Rowe (1969), by erecting new genera she disregarded a number of appropriate prior genus group-names of Brandt (1835), Jaeger (1833), Haacke (1880) and Pearson (1914) on the grounds of poor definition; most of these names are available under the rules, being associated with recognised species, those of Jaeger and Brandt needing only designation of type-species in order to qualify for recognition under the rules. Deichmann (1958) stated that there was nothing new about her classification, since this type of arrangement of the species on the basis of ecological divisions has been foreshadowed in the key of Fisher (1907) for the Hawaiian holothurians. She based her classification mainly on ecological division. She was of the view that within each habitat are groups in different stages of development, which can be separated by means of their spicules. She was also of the view that the most primitive ones are those with regular tables and rosettes. This is exactly opposite to the view of Pearson. She based her revision predominantly on the species from the East Pacific and left unconsidered a number of others from different parts of the world, so that her revision was necessarily incomplete.

Rowe (1969) reviewed the Family Holothuriidae and proposed a new classification. He had two great advantages. He had access to the vast collections of the British Museum and also the benefit of advice of Miss A.M. Clark, the foremost echinodermologist in the world today. He considered the balance of those species not taken into consideration by Deichmann and brought her system into line with the rules of nomenclature. During the last 20 years, most of the specialists like Liao (1975, 1978), Price (1981, 1982, 1983), A.M. Clark (1980, 1984), Price and Reid (1985), Marsh (1986), James (1986a, 1989a) and Cherbonnier (1988) followed his classification without any comment. The classification proposed by Rowe is technically sound and is in conformity with the rules of nomenclature. It is hoped that other species under the genus will be assigned to the various subgenera in due course.

During the last thirty years, I made extensive collections from various places along the mainland of India and collected large samples from the Gulf of Mannar and Palk Bay. I also collected material from the Lakshadweep and the Andaman and Nicobar Islands. From the literature, it is seen that 26 species are known from the seas around India. In this paper 18 species collected by me are described with notes on synonymy, habits and, in some cases, remarks. *Holothuria rugosa* is already referred to the genus *Labidodemas* and is placed under a new family Labidodematidae by James (1981b). Special care is taken to see that all the species of *Holothuria* mentioned in earlier papers are correctly assigned as far as possible. Some of the corrections have already been notified by James (1983). The diagnosis and keys to various subgenera are taken from Rowe (1969).

Genus *Holothuria* Linnaeus, 1767

Diagnosis: Tentacles 17-30, usually 20, papillae and pedicels arranged variously on the dorsal and ventral sides respectively; anal papillae variously developed or absent; body wall 2-20 mm in thickness; body form variously developed, vermiform, cylindrical or with the ventral side distinctly flattened and 'sole'-like, dorsally arched; size ranging from small to large even up to 600 mm in length; calcareous ring more or less well developed, usually with radial plates two or three times as long as interradial plates, anterior margin of the ring rarely scalloped, posterior margin undulating (except in the subgenus *Theelothuria* where the radial plates bifurcate posteriorly); spicules very diverse and variously developed, tables present or absent, rosettes and small branched rods sometimes present.

Type species: *H. tremula* Linnaeus, 1767 (non *H. tremula* Gunnerus, 1767= *H. tubulosa* Gmelin, 1890: Validated, Opinion 80, 1924: 17-18).

26 species of *Holothuria* belonging to 12 subgenera are reported from the seas around India. Of these, 18 species belonging to all the 12 subgenera have been collected and described in detail in this work. Keys to all the species known from the sea around India are given. The following key to the various subgenera is modified from Rowe (1969).

KEY TO THE SUBGENERA OF THE GENUS

1. Spicules: perforated or thorny rods or plates; tables and buttons absent . . . . *H. (Selenkothuria)* Deichmann, 1958

1'. Spicules: tables always present, usually well developed, alone or in combination with buttons, pseudobuttons, rods or rosettes 2

2. Spicules: tables always present in combination with rods or rosettes, never with buttons or pseudobuttons 3

2'. Spicules: tables always present in combination with buttons or pseudobuttons, no rosettes or rods . . 5

3. Spicules: tables present in combination with rosettes; no rods in body wall 4

3' Spicules: tables present in combination with rods in the body wall, tables usually with reduced disc and spire of moderate height, either rounded at the tip or terminate in a few spines which form a single or double Maltese cross when viewed from above; no rosettes . . . . *H. (Semperothuria)* Deichmann, 1958

4. Spicules: tables usually with reduced disc and moderately high or high spire, ending in a few spines forming a Maltese cross when viewed from above . . . . *H. (Halodeima)* Pearson, 1914

4'. Spicules: tables large and clumsy with spinose well-developed disc, its rim is often turned up to give a 'cup and saucer' appearance to the table in lateral view, spire low to moderate height . . . . *H. (Acanthotrapeza)* Rowe, 1969

5. Spicules: tables variously developed, never modified into hollow fenestrated spheres; buttons smooth, regularly or irregularly developed, often twisted. . . .6

5'. Spicules: tables always strongly developed, sometimes modified into hollow fenestrated spheres; buttons always knobbed or rugose or modified to form hollow fenestrated ellipsoids 9

6. Spicules: tables usually well developed, the rim of the disc not spinose; buttons not twisted, sometimes flat and thin, with or without an apparent median longitudinal ridge, outlines regular or irregular. 7

6'. Spicules: tables more or less well developed, disc usually spinose; buttons irregular or twisted, never flattened, lacking any appearance of a median longitudinal ridge 8

7. Spicules: tables well developed, disc smooth and round, usually with ten or more peripheral holes, spines of moderate height, ending in several small spines; buttons oval, thin, flat, very rarely with a few knobs, an apparent median longitudinal ridge present, three to six pairs of relatively small holes, buttons regular or irregular in outline . . . . *H. (Platyperona)* Rowe, 1969

7'. Spicules: tables fairly stout, disc smooth, squarish in outline, usually with eight regular peripheral holes, spire of moderate height ending in a cluster of small spines; buttons not thin or flat and lacking any appearance of longitudinal ridge usually with three pairs of comparatively large holes and regular in outline . . . . *H. (Thymioscycia)* Pearson, 1914

8. Spicules: tables not strongly developed, rim of disc usually spinose, spire low, ending usually in a ring of spines or cluster of spines, tables occasionally degenerate or incomplete; buttons irregular though not twisted, usually with three pairs of holes, or else

incomplete, forming small lobed rosette-like bars . . . . *H. (Mertensiothuria)* Deichmann, 1958

8'. Spicules: tables always well developed rim of disc spinose and turned up to give a 'cup and saucer' aspect to the table in lateral view, spire low to moderate in height, usually terminating in a ring or a cluster of small spines; pseudobuttons abundant, smooth, usually irregular and often reduced to single row of three or four holes, occasionally buttons quite regular with three pairs of holes . . . . *H. (Lessonothuria)* Deichmann, 1958

9. Spicules: tables with disc usually knobbed, spire low, bearing many short spines which are sometimes so numerous and closely crowded that they may almost either obscure the disc or become connected to the knobs of the margin of the disc, thus forming a fenestrated sphere; buttons usually simple, with large regularly or irregularly arranged knobs, generally three to four or more pairs of relatively small holes which may become somewhat obscured by the size of the large knobs . . . . *H. (Cystipus)* Haacke, 1880

9'. Spicules: tables stout, well developed spire moderate or high, never modified into hollow fenestrated ellipsoids 10

10. Spicules: tables well developed, disc smooth or spinose, spires either moderate or high, usually terminating on a cluster of small spines, tables with spires perfectly smooth and tapering to a point, giving the whole table a tack-like appearance usually also present; buttons either simple with irregular, moderate sized knobs, or modified into hollow fenestrated ellipsoids, calcareous ring with radial plates usually possessing more or less well developed posterior bifurcate prolongations . . . . *H. (Theelothuria)* Deichmann, 1958

10'. Spicules: tables well developed, disc smooth, often squarish in outline, spire of moderate height or high, terminating in small spines, never pointed and tack-like, buttons simple with moderate sized knobs or modified into hollow fenestrated ellipsoids, calcareous ring never with any indication of posterior bifurcate prolongations on the radial plates 11

11. Spicules: tables well developed with smooth disc, spire of moderate height or high, terminating in several small spines; buttons simple, with moderate sized, irregularly arranged knobs and three to six pairs of relatively large holes, buttons never modified into hollow fenestrated ellipsoids . . . . *H. (Metriatyla)* Rowe, 1969

11'. Spicules: tables as per 11, buttons hollow fenestrated ellipsoids though a few simple knobbed buttons may be present . . . . *H. (Microthele)* Brandt, 1835

Subgenus *Selenkothuria* Deichmann, 1958

Diagnosis: Tentacles 20; pedicels crowded but more or less distinctly arranged in three rows on the ventral 'sole', papillae small, numerous, scattered dorsally; body wall soft, not very thick, about 1-3 mm; body with flattened ventral 'sole' and arched dorsally; size moderate up to 150 mm long; calcareous ring with radial plates up to three times as long as the interradial plates, the latter usually with the outer surface slightly concave; spicules consisting of perforated or rugose plates or rods, tables rare or more often totally absent.

Type species: *Holothuria lubrica* Selenka, 1867 (Designated by Deichmann, 1958: 314).

Two species are known under this subgenus from the Indian seas. Both the species have been collected and described in the present work.

KEY TO THE SPECIES OF THE SUBGENUS

Spinose rods present, colour brown . . . . *H. (Selenkothuria) moebii* Ludwig, 1833

Flattened plates and rods present; colour brownish-black.. . . . . *H. erinaceus* Semper, 1868

Holothuria (Selenkothuria) moebii Ludwig
(Fig. 1, A)

Holothuria moebii Ludwig, 1833, p. 171; James, 1969, p. 61: Gulf of Mannar & Arabian Sea; James, 1982, p.5; James, 1988b, p. 404: Gulf of Mannar.

Holothuria lubrica Koehler & Vaney, 1908, p. 10: Andaman Islands, Sri Lanka. (Non *H. lubrica,* Selenka, 1867); Gravely, 1927, p. 163: Gulf of Mannar; Satyamurti, 1976, P. 45: Shingle & Krusadai Islands.

Holothuria (Selenkothuria) moebii Mary Bai, 1980, p. 11; James, 1986a, p. 585: Sri Lanka, Gulf of Mannar-Palk Bay.

Material: Mandapam Camp (Gulf of Mannar), 1 specimen; Vizhinjam (Arabian Sea), 4 specimens; Ratnagiri (Arabian Sea), 2 specimens, all collected from the intertidal region attached to stones.

Description: Length ranges from 137 mm to 146 mm. Body spindle-shaped, with a bulge at the middle when alive. Ventral side clearly demarcated into a 'sole' which has four distinct rows of pedicels. Dorsally, the papillae are sparsely arranged. In one specimen dissected there were 19 small stone canals and a single polian vesicle.

Calcareous ring large and massive. Radials much larger than the interradials and circular in outline with a cleft at the top. Interradials like small stumps.

Spicules (Fig. 1, A) consist of spinose rods with finely spinulated surface. Mostly simple with a hole at each end. Some of the rods have three or four rays. The length of the rods varies from 0.052 to 0.189 mm and the breadth from 0.010 to 0.049 mm. Pedicels have large end plates and curved rods.

The colour in the living condition is dark brown on the dorsal side and light brown on the ventral side.

Notes on habits: This species is collected near the low water mark under stones. They were found to be firmly attached to rocks by the pedicels. During low tide the holothurians contract and become bulged at the centre and remain in the same condition until the tide rises. H.L. Clark (1938) has stated that the normal habitat of the species is well below the lower water mark in the face of the reef.

Distribution: It is known from Mauritius, Sri Lanka, Bay of Bengal, East Indies, North Australia, Philippines, China & Southern Japan and the South Pacific Islands. It was recorded for the first time from the Arabian Sea by James (1969).

Holothuria (Selenkothuria) erinaceus Semper (Pl. 1, A & B and Fig. 1, B & C)

Holothuria erinaceus Semper, 1968, P. 91: North Australia, Philippines, South Pacific Islands.

Holothuria andersoni Bell, 1886, p. 28: Mergui Archipelago.

Holothuria marenzelleri Ludwig, 1887, p. 1229: Ceylon (Sri Lanka); Theel, 1886, p. 207: Nicobar.

Holothuria lubrica var. *glaberrima* Panning, 1934, p. 47.

Holothuria (Selenkothuria) erinaceus Mary Bai, 1980, p. 11; Soota, Mukhopadhyay & Samanta, 1983, p. 512: Interview Island, Port Blair, Nancowry; James, 1986a, p. 585. Sri Lanka, Andaman-Nicobar Islands.

Holothuria (Selenkothuria) glaberrima Soota *et al.*, 1983, p. 519: Andaman & Nicobar Islands.

Material: Port Blair (Andamans), several specimens, collected from mud-flats in the intertidal region.

Description: Ranges in size from 60 to 160 mm in length. This species does not grow to a large size. Body spindle-shaped with a very soft body wall. Posterior end narrow with the anus surrounded by fine papillae. One of the specimens collected had two posterior ends (Pl. 1, B). Tentacles small. Dorsally a few scattered papillae. Ventrally the pedicels are arranged in three bands. In the central band, the pedicels are arranged in two rows, and in the other two bands they are arranged in a single row.

A single polian vesicle, very few cuvierian tubules present, radials rectangular with a distinct notch at the anterior end and a concavity at the posterior end (Fig. 1, C). Interradials half the size of the radials and have a distinct stump at the anterior end.

Spicules (Fig. 1, B) mostly short, flat, dumb-bell shaped rods with a few lateral or terminal holes. there are also a few oval plates with several holes at the margin. The length of the rods varies from 0.052-0.082 mm and breadth from 0.019 mm to 0.032 mm.

In the living condition the colour is light brown to brownish-black. Small specimens are light pink in colour.

Notes on habits: The species is distributed in the supra-littoral zone. It is usually found under stones. At low tide, on lifting stones the anterior end of the body is seen as a brown round patch free from sand and in a shallow depression. The posterior end is also kept near the surface of sand since, on disturbing the animal, a jet of water is released. In the Marina area near Port Blair where there is a lot of mud 3-5 specimens were distributed per square metre. On walking over the mud, due to the pressure caused on the surrounding area, a jet of water is ejected by nearby specimens. Though common, it is overlooked unless one makes a careful search for it in the supralittoral zone. In some places it is truly gregarious. As many as 30 specimens were distributed in a one square metre area at some places. When the tide recedes, they come out of the sand or mud and keep a small portion of the anterior end (about 30 mm in length) outside with the tentacles spread out.

Distribution: It is known from Sri Lanka, Bay of Bengal, East Indies, North Australia, Philippines and South Pacific Islands.

Subgenus *Semperothuria* Deichmann, 1958

Diagnosis: Tentacles 20; pedicels more or less distinctly arranged in three rows on the ventral side, papillae scattered dorsally; body-wall soft, not very thick (1-4 mm); body slender and cylindrical; size moderate up to 150 mm long; calcareous ring quite well developed, radial plates up to three times as long as the interradials; spicules consisting of tables in combination with rods, the former with disc reduced or absent, spire high and terminating in a few spines which form a single or double Maltese cross when viewed from above, rosettes totally absent.

Type species: *Holothuria languens* Selenka, 1867; designated by Deichmann, 1958: 303.

Two species are known under this subgenus from the seas around India.

KEY TO THE SPECIES OF THE SUBGENUS

Only tables with flattened base in the body wall .... *H. (Semperothuria) imitans* Ludwig, 1875

Tables and finely spinose rods in the body wall .... *H. (Semperothuria) cinerascens* (Brandt, 1835)

Holothuria (Semperothuria) cinerascens (Brandt)

Stichopus (Gymonochirota) cinerascens Brandt, 1835, p. 51.

Holothuria cinerascens Bell, 1867b, p. 654: Ceylon (Sri Lanka); Pearson, 1913, p. 64: Maldives, Seychelles, Ceylon (Sri Lanka); James 1969, p. 61: Mandapam (Gulf of Mannar), Vizhinjam (Arabian Sea), Minicoy (Lakshadweep), Rangat Bay (Andamans); Daniel and Haldar, 1974, p. 428: Lakshadweep and Maldives.

Halodeima cinerascens Clark and Davies, 1965, p. 600: Maldives.

Holothuria (Semperothuria) cinerascens Mary Bai & Ramnathan, 1977, p. 380: Coast of Kanyakumari (Cape Comorin); Mary Bai, 1980, p. 11; A.M. Clark, 1984, p. 99: Seychelles; Sirvoiker & Parulekar, 1986, p. 279: Goa; Mukhopadhyay & Samanta, 1983, p. 302: Lakshadweep; James, 1983, p. 93; Soota, Mukhopadhyay & Samanta, 1983, p. 513: Rutland Island (Andamans); James, 1986a, p. 585: Lakshadweep-Maldives, Sri Lanka; Mukhopadhyay, 1988, p. 1988, p. 4: Krusadai Island; James 1989b, p. 124: Chetlat, Bitra, Kiltan, Amini, Androth, Kavaratti, Minicoy (Lakshadweep).

Material: Mandapam (Gulf of Mannar), 1 specimen; Ratnagiri (Arabian Sea), 2 specimens; Vizhinjam (Arabian Sea), several specimens; Chetlat, 2 specimens; Bitra, 2 specimens; Kiltan, several specimens; Kadmat, 3 specimens; Amini, several specimens; Androth, one specimen; Kavaratti, 3 specimens; Minicoy, several specimens; all specimens collected under coral stones.

Description: Ranges in length from 30 mm to 200 mm. Robust, sub-cylindrical with dorsal and ventral sides sharply differentiated. Dorsal surface covered with uniformly distributed numerous papillae. Ventrally beset with crowded robust pedicels. Tentacles 20 in number, large and sub-globose when fully expanded. Mouth ventral. Posterior end of the body blunt. Anus surrounded by papillae. Body wall thick and fairly smooth to touch. Pedicels more or less arranged in three rows. Papillae of dissimilar sizes. In the living condition the tentacles, though peltate, appear to be slightly arborescent. The collar surrounding the tentacles is inconspicuous.

The calcareous ring is of the usual type. There were four polian vesicles of dissimilar size in one specimen dissected. On the right side of the mesentery there is a single stone canal. Cuvierian tubules are well developed. Longitudinal muscle bands are thin.

Spicules (Fig. 1, D) are of two types, namely tables and rods. Rods simple and finely granulated, a characteristic of the species. They are either straight or curved with the extremities often branched or with coarser tubercles. Occasionally, triradiate and tetraradiate rods occur with three or four ends considerably branched. The length of the rods varies from 0.10 mm to 0.30 mm. Tables simple with the annular disc varying in size from 0.042 mm to 0.060 mm. Four large holes at the centre and four large holes near the margin in each disc of the table. The crowns of the tables are subquadrate, being 0.045 mm in diameter.

Colour in living condition is reddish-brown with some of the papillae and pedicels yellowish in colour.

Notes on habits: This species is characteristic of rocky shores. Both small and large forms (30-200 mm in length) were found at the same locality in large numbers. Individuals were often found attached firmly at the rock edges by the three rows of pedicels on the ventral side. The tips of the peltate tentacles are branched, and during high tide the tentacles were observed to move gently, probably to procure planktonic food. It is provided with profuse cuvierian tubules which are discharged when the animal is disturbed. It is a surf-loving form extending up to the supralittoral zone. During low tide, individuals are exposed for a long time but they remain in the splash zone.

Distribution: It is known from islands of the Western Indian Ocean, Mascarene Islands, East Africa, Red Sea, South East Arabia, Maldives, Sri Lanka, East Indies, North Australia, Philippines, Japan, South Pacific Islands and Hawaiian Islands. James (1969) recorded this species for the first time from the Arabian Sea.

Subgenus *Halodeima* Pearson, 1914

Diagnosis: Tentacles 20; pedicels in three distinct but crowded rows on the more or less distinctly 'sole'-like ventral side, papillae small and irregularly arranged on the dorsal surface; body wall soft, quite thick, usually 2-3 mm; body almost cylindrical; size moderate to large, up to even 600 mm long; calcareous ring quite stout, radial plates up to three times the length of the interradials; spicules consist of tables usually with reduced disc, spire moderate or high, ending in a few spines forming a Maltese cross when viewed from above, no large flattened or spinose rods present in the body wall.

Type species: *Holothuria edulis* Lesson, 1830; designated by H.L. Clark, 1921, p. 184.

Remarks: The genus *Ludwigothuria* Deichmann, 1958 is a synonym of this subgenus.

Two species are known under this subgenus from the Indian Seas. Both the species have been collected and described in this work.

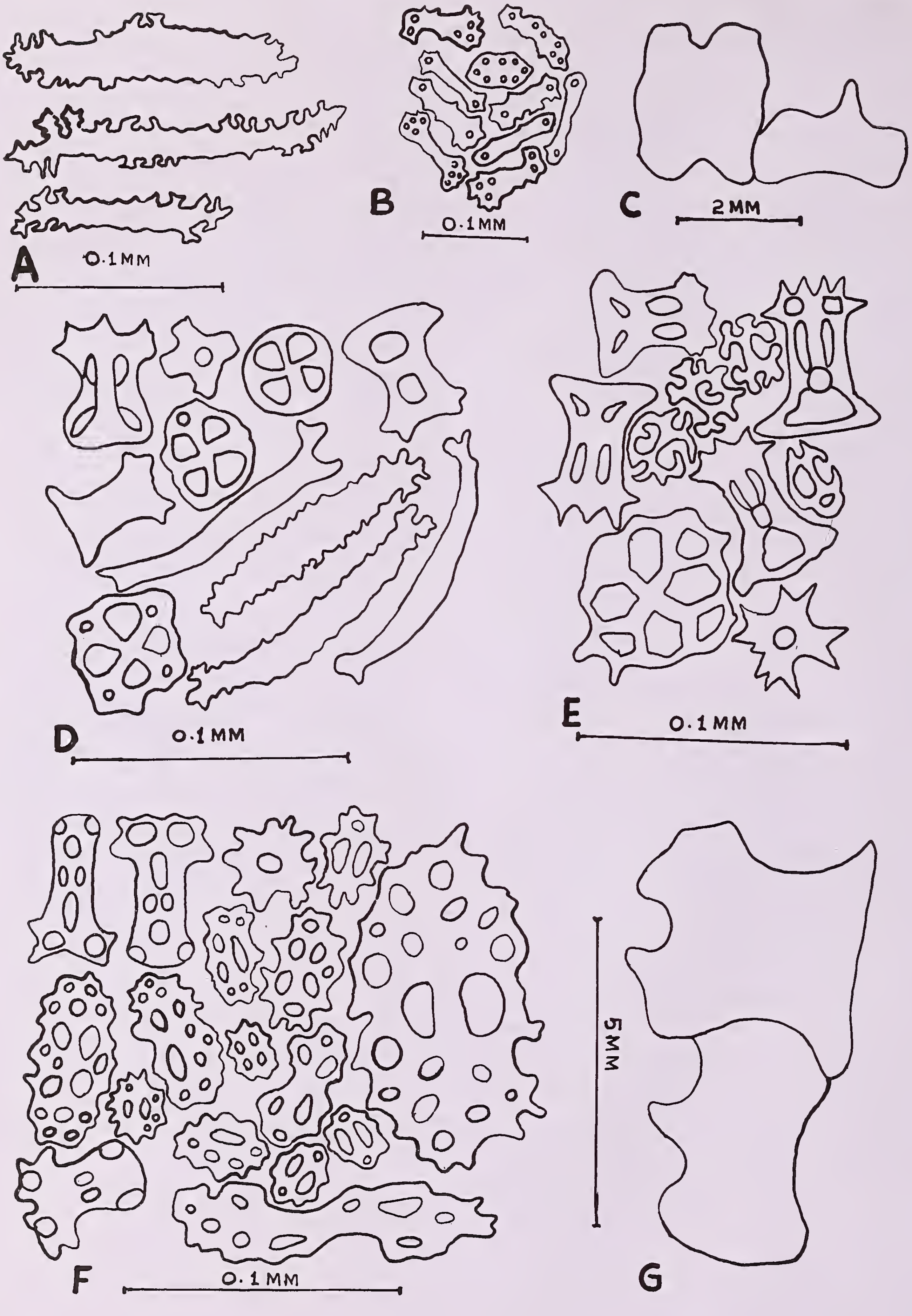


Fig. 1. Spicules of A. *Holothuria (Selenkothuria) moebii*, B. *Holothuria (Selenkothuria) erinaceus;* C. Radial and interradial plates of *Holothuria (S.) erinaceus*; D. *Holothuria (Semperothuria) cinerascens*; E. *Holothuria (Halodeima) atra*; F. *Holothuria (Halodeima) edulis*; G. Radial and interradial plates of *Holothuria edulis.*

KEY TO THE SPECIES OF THE SUBGENUS

Spicules: rosettes present, discs of tables small; colour uniformly dark brown or black .... *H. (Halodeima) atra* Jaeger, 1833

Spicules: rosettes absent, discs of tables reduced to ring; dorsal side black and ventral side pink .... *H. (Halodeima) edulis* Lesson, 1830

Holothuria (Halodeima) atra Jaeger

Holothuria atra Jaeger, 1833, p. 22; Bell, 1887a, p. 140: Andaman Islands; Bell, 1887b, p. 654: Ceylon (Sri Lanka); Ludwig, 1887, p. 1217: Ceylon; Bell, 1888, p. 389: Tuticorin; Thurston, 1894, p. 115: Pamban; Pearson, 1903, p. 202: Ceylon (Sri Lanka); Herdman & Herdman, 1904, p. 447: Ceylon (Sri Lanka); Koehler & Vaney, 1908, p. 5: Andaman Islands, Galle (Sri Lanka), Flat Island, coast of Arakan; Pearson, 1913, p. 67: Sri Lanka; Gravely, 1927, p. 164: Gulf of Mannar; Patil, 1953, p. 430: Karwar; James, 1969, p. 62: Gulf of Mannar & Palk Bay; Jones & James, 1970, p. 799: Vedalai, Shingle Island, Mandapam; James, 1973, p. 708: Southeast coast of India; Daniel & Haldar, 1974, p. 428: Lakshadweep & Maldives; Satyamurti, 1976, p. 42: Rameswaram, Krusadai Island; Nagabhushanam & Rao, 1979, p. 290: Minicoy Atoll (Lakshadweep); James, 1982, p. 5; James, 1983, p. 98; Rao *et al.* 1985, p. 11: Gulf of Mannar; Tikader & Das, 1985, p. 99: Andaman & Nicobar Islands; Tikader *et al.* 1986, p. 117: Andaman & Nicobar Islands; James, 1986b, p. 4: James, 1986c, p. 1340: Andamans & Mandapam; James, 1988, p. 44: Gulf of Mannar.

Holothuria (Halodeima) atra Soota *et al.* 1983, p. 510: Campbell Bay, Port Blair, Car Nicobar, Long Island, Little Andaman, Interview Island; Mary Bai, 1980, p. 12: Price & Reid, 1985, p. 3: Chetlat (Lakshadweep), Galle & Kalpitiya (Sri Lanka); Mukhopadhyay & Samanta, 1983, p. 302: Lakshadweep; James, 1986a, p. 585: Lakshadweep-Maldives, Gulf of Mannar-Palk Bay, Andaman-Nicobar Islands; Mukhopadhyay, 1988, p. 5: Krusadai Island, Mandapam Camp; James, 1989b, p. 189: Chetlat, Kiltan; Kadmat, Amini, Agatti, Kavaratti.

Material: Mandapam, Tuticorin (Gulf of Mannar), several specimens; Devipatnam (Palk Bay), several specimens; Vizhinjam, 2 specimens; Karwar, 2 specimens; Chetlat, several specimens; Kiltan, several specimens; Kadmat, 5 specimens; Amini, 3 specimens; Agatti, several specimens; Kavaratti, 2 specimens; all specimens collected from the intertidal region.

Description: Length from 90-500 mm but known to grow up to 600 mm. Body elongate, subcylindrical and capable of considerable extension. Posterior end blunt. Mouth in the form of a transverse slit and surrounded by a conspicuous papillose collar. There are 20 tentacles in a double row. Pedicels numerous and crowded on the ventral side. Papillae rather thicker than the pedicels and sparsely arranged. Peristome rather thick, tough and leathery in consistency. Anus terminal.

The calcareous ring is not very large. The radial pieces extend farther forward than interradials. Radials square-shaped, the anterior edge of each radial has a rounded incision while each interradial piece has an anterior tooth. Posterior margin of the interradial arched. In a specimen dissected there were four polian vesicles and 18 stone canals. The right respiratory tree extends forward to the calcareous ring and is firmly attached to the body wall and the left one, which is shorter, is connected with the extensive rete mirabile of the intestine. Cuvierian tubules absent.

The spicules (Fig. 1, E) consist of tables and rosettes. Tables numerous but not crowded. Each table possesses a smaller annular disc and a robust spire composed of four rods and one cross beam. Disc diameter 0.055 mm and commonly consists of a simple ring with perforation at the base of each rod. Cross beam nearer to the disc than to the crown. Spire surrounded by eight robust horizontal and four equally strong, sharp, large vertical teeth. Central hole of the spire subcircular. Height of the spire varies from 0.06 mm to 0.08 mm and the breadth of the crowns is about 0.06 mm. Rosettes small and vary in size from 0.019 to 0.045 mm. Pedicels have well developed terminal plates. A few bilaterally symmetrical fenestrated plates are present close to the terminal plates of the pedicels. The papillae contain slightly curved smooth or spinose rods, mostly with enlarged fenestrated ends.

In the living condition, the colour is black or very dark brown or reddish-brown. The pedicels have white sucking discs and the papillae have white tips. The stocks of the pedicels and papillae are always black. The tentacles and the peristome are dark brown.

Notes on habits: This is one of the most common holothurians around Indian Seas. It is always found fully exposed in shallow water on sandy bottoms. During low tide where water remains as a pool this species is found but it is never encountered under stones.

Specimens ranging from 110-230 mm were found in the lagoon with sand coated on them. Of the 46 specimens examined in the field on one occasion, only two were free from sand on the body. Usually specimens ranging in size from 110-160 mm were common in the lagoon. At some places 1-10 specimens were found to be distributed per square metre. Specimens collected on the outer side of the reef were large (400 mm in length) and were found to have the alga *Halimeda* inside the alimentary canal. Suspended matter like mud and sand settles on the surface of the animal and forms a coat. Often there are paired rows of round spots free from sand or mud. This is due to the presence of two rows of dorsal papillae.

Bakus (1973) stated this species has a toxin known as holothurin which kills many forms of life in a tide pool. James (1986c) described the experiments conducted at Port Blair (Andamans) and also at Mandapam. The toxin kills all marine life in two hours time when put in a rock pool.

Jones and James (1970) reported an endoparasitic gastropod *Stilifer* sp. from the cloaca of this species. The occurrence of the parasite is very rare and they also described its early development. Waren (1983) referred it to the genus *Megadenus*.

Conand (1990) has stated that this species is of low commercial value. *H. atra* was collected for processing at Vedalai for the first time in 1992. The specimens ranged from 180-310 mm in length. The processed material is sold at the rate of Rs. 50.00 per kilogram.

Distribution: It is known from the islands of the Western Indian Ocean, Mascarene Islands, East Africa, Red Sea, South East Arabia, Persian Gulf, Maldives, Sri Lanka, Bay of Bengal, East Indies, North Australia, Philippines, Japan, South Pacific Islands and Hawaiian Islands.

Holothuria (Halodeima) edulis Lesson

(Fig. 1, F & G)

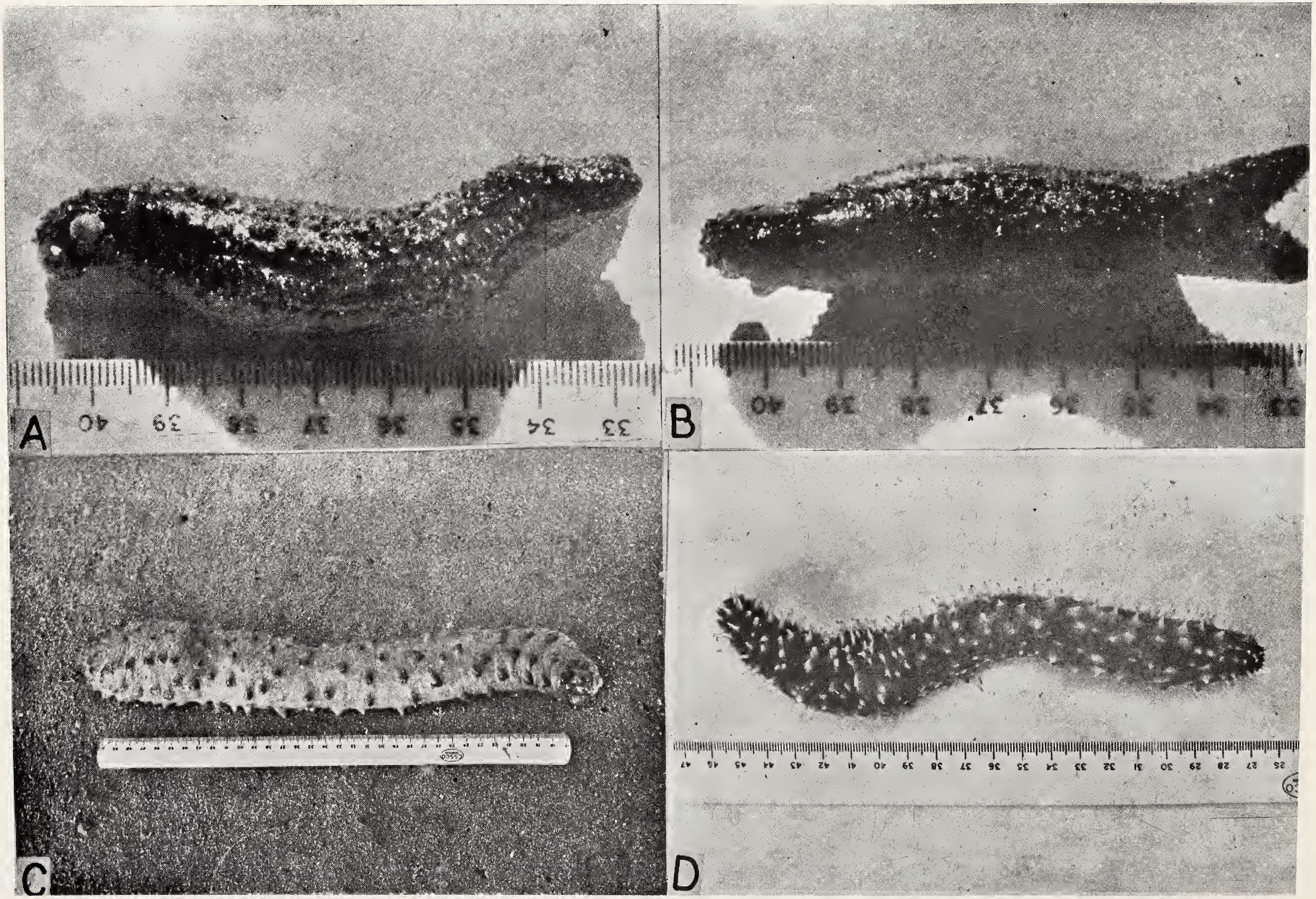
Holothuria edulis Lesson, 1830, p. 125; Ludwig, 1887, p. 1227: Ceylon (Sri Lanka); Koehler & Vaney, 1908, p. 7: Andaman Island; James, 1969, p. 61: Gulf of Mannar; James, 1982, p. 5; James, 1983a, p. 98; James, 1988b, p.404: Gulf of Mannar.

Holothuria albida Bell, 1887a, p. 140: Andaman Island; Daniel & Haldar, 1974, p. 410: Andamans.

Holothuria (Halodeima) edulis Mary Bai, 1980, p. 12; Soota *et al.*, 1983, p. 519: Andaman & Nicobar Islands; Price & Reid, 1985, p. 4: S.W. Kalpitiya (Sri Lanka); James, 1986a, p. 585: Lakshadweep-Maldives, Andaman-Nicobar Islands; Mukhopadhyay, 1988, p. 6: Tuticorin.

Material: Mandapam (Gulf of Mannar), 4 specimens, 15 metres; Tuticorin (Gulf of Mannar), 18 metres; Port Blair (Andamans), 2 specimens, 14 metres.

Description: Length from 90 mm to 300 mm. Body elongate, narrow at the anterior end and blunt at the posterior end. Minute papillae found on the dorsal side of the body. Numerous pedicels on the ventral side. An arrangement into three rows is discernible in one of the specimens. There are 20 medium-sized tentacles surrounded by a rim of black papillae. Skin smooth and thin. The inner wall of the cloaca is black in colour.



A. *Holothuria* (*Selenkothuria*) *erinaceus* (normal specimen); B. *Holothuria* (*Selenkothuria*) *erinaceus* (specimen with two posterior ends); *Holothuria* (*Acanthotrapeza*) *pyxis*; D. *Holothuria* (*Thymiosycia*) *hilla*.

The calcareous ring (Fig. 1, G) is of moderate size. In one specimen dissected there are 37 stone canals and one polian vesicle. Both the right and left branches of the respiratory trees are large and of equal size.

Spicules (Fig. 1, F) consist of tables and buttons. Discs of tables reduced to a ring which is narrower than the top of the spire. There is a horizontal beam in the middle of the spire. The top of the spire is expanded and bears four blunt spines on each side which can be seen only in the lateral view. Height of the table varies from 0.052 mm to 0.066 mm and diameter of the spire varies from 0.037 mm to 0.043 mm. Small buttons present in the inner layer. The number of holes varies from 3 to 10 and most of them are incomplete. Length of the buttons varies from 0.026 mm to 0.058 mm and the breadth from 0.017 mm to 0.031 mm. Long supporting rods which have expanded ends and three to four holes are present in the pedicels.

In the living condition the body is bright rose pink which may be obscured by varying degrees of black pigment. The black colour is well marked on the dorsal side where it varies from grey to intense black and at the side it is replaced by pink. On the ventral side there is no black colour.

Notes on habits: Both in the Gulf of Mannar and at Andamans around Port Blair, this species was collected from shallow depths (4-18 metres). It was never encountered in the intertidal region at both the places. Rowe and Doty (1977) report this species in the intertidal region under stones.

Distribution: It is known from East Africa, Red Sea, S.E. Arabia.

Subgenus *Acanthotrapeza* Rowe, 1969

Diagnosis: Tentacles 20; pedicels irregularly arranged on the ventral side, papillae small to large and conical, arranged irregularly on the dorsal side; body wall soft, fairly thick, usually 3 (2-5) mm; body almost cylindrical but sometimes ventrally flattened and 'sole'-like; size small to large, up to 450 mm long; calcareous ring stout, radical plates squarish, up to twice as long as interradials; spicules consisting of tables in combination with rosettes, tables usually large and clumsy with well developed spinose disc and low to high spire, the rim of the disc is often turned up to give the tables a cup-and-saucer appearance in lateral view.

Type species: *Holothuria pyxis* Selenka, 1867; designated by Rowe, 1969: 138. Three species are included under this subgenus. Only one species is known from Indian Seas.

Holothuria (Acanthotrapeza) pyxis Selenka
(Pl. 1, C; Fig. 2, A & B)

Holothuria pyxis Selenka, 1867, p. 337: Java; Koehler & Vaney, 1908, p. 14: Andamans; James, 1982, p. 5; Daniel & Haldar, 1974, p. 419: Andamans; James, 1983, p. 93: South Andamans; Tikader *et al.* 1986, p. 120: Andaman & Nicobar Islands; James, 1987, p. 110: Andamans.

Holothuria papillata Bell, 1887a, p. 145: Andaman Islands.

Holothuria (Acanthotrapeza) pyxis Mary Bai, 1980, p. 12; Soota, Mukhopadhyay & Samanta, 1983. p. 509: Nancowry (Camorta Island); James, 1986a, p. 34: Andaman-Nicobar Islands; James, 1986d, p. 34: South Andamans.

Description: The length of the specimens examined varied from 270-450 mm. The body is tubular. The posterior region is bulged and blunt with the anterior end narrow. A number of projections are found on the dorsal side. Some of them are 20 mm in length. They are not arranged according to any order. However, in the smallest specimen (270 mm in length) on the mid-dorsal region there is a double row of tubercles, the arrangement of which is not very distinct. The projections at the sides are not distinctly arranged as a row. In the smallest specimen there are 25 projections longitudinally

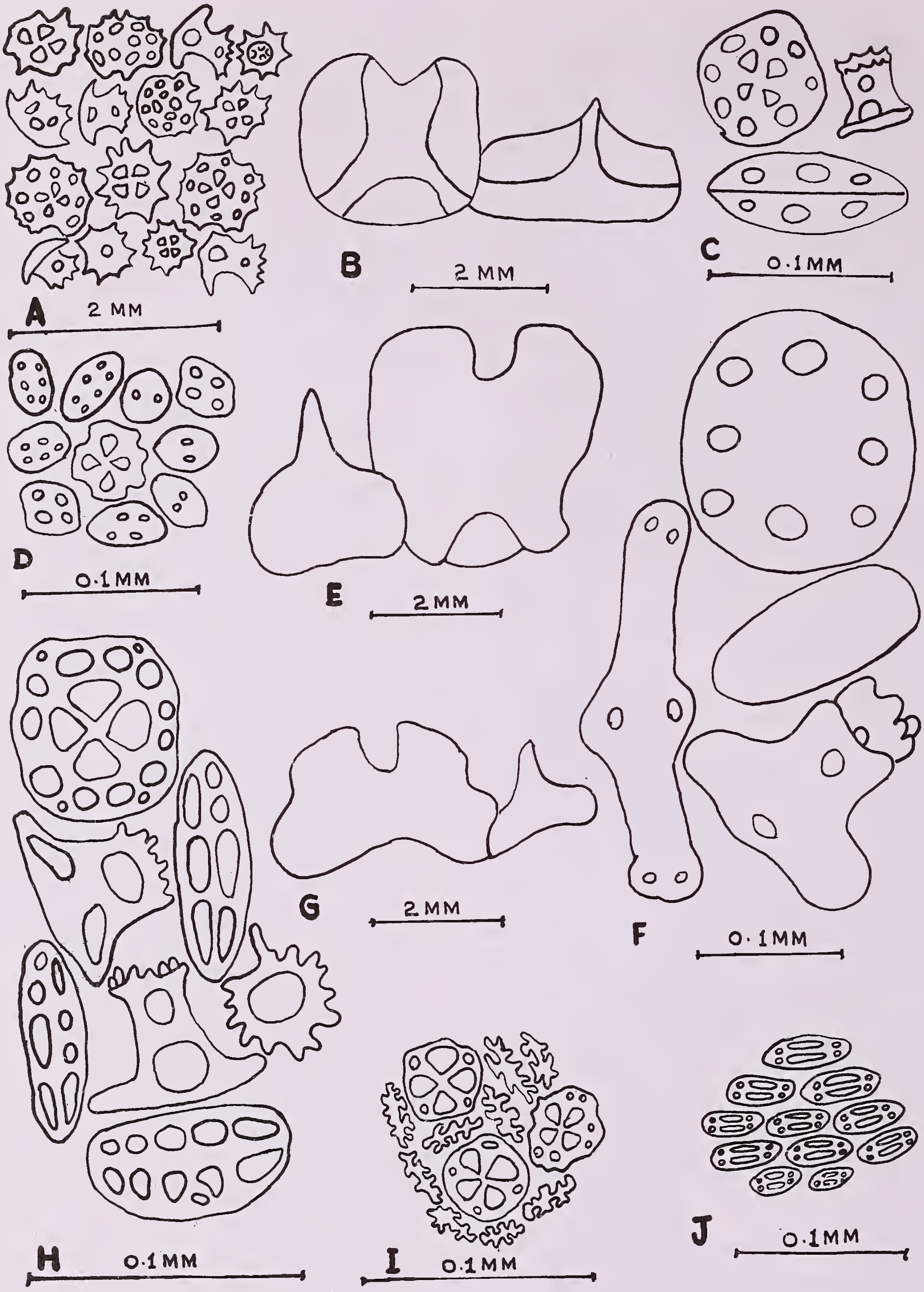

A
2 MM
B
2 MM
C
0.1MM
D
0.1MM
E
2MM
G
2MM
F
0.1MM
H
0.1MM
I
0.1MM
J
0.1MM

Fig. 2. Spicules of A. *Holothuria (Acanthotrapeza) pyxis*, B. Radial and interradial plates of *Holothuria (A.) pyxis*; C. *Holothuria (Platyperona) difficilis*; D. *Holothuria (Thymiosycia) arenicola*; E. Radial and interradial of *Holothuria (T.) impatiens*; F. *Holothuria (Thymiosycia) impatiens*; G. Radial and interradial plates of *Holothuria (T.) hilla*; H. *Holothuria (Thymiosycia) hilla*; I. *Holothuria (Mertensiothuria) pervicax*; J. *Holothuria (Mertensiothuria) fuscocinerea*.

and four transversely. In the largest specimen (450 mm in length), there are 35 projections longitudinally and five to seven projections transversely. On the ventral side, there are four bands of pedicels. In each band there are five or six pedicels arranged side by side. The pedicels are not evident in preserved specimens.

Radials large with a deep notch at the anterior end, the posterior end straight (Fig. 2, B). Interradials half the height of the radials and have a concavity at the posterior margin. A single stone canal and a single polian vesicle.

The spicules (Fig. 2, A) consist of only tables in the body wall. Margins of the tables spiny with four large holes at the centre and a number of small holes around the margin. Tables short and end in about 10 short spines. Height of the tables is 0.04 mm and diameter of the disc of the tables 0.05 mm.

In the living condition, the dorsal side is brownish-pink with some of the tubercles blackish brown. The ventral side is light brown, with spaces between the bands of the pedicels yellow.

Distribution: It is known only from the East Indies and the Andaman Islands. This species is highly secretive and is likely to be taken at other places in the Indo-Pacific region.

Notes on habits: The species is always found under large stones which are well fixed to the ground. The long and narrow anterior region is kept out and is seen in constant movement like a snake. It is impossible to pull out the specimen without damaging it since the posterior end is firmly fixed in a crevice of the rock. *Holothuria (Mertensiothuria) leucospilota* also exhibits similar habit though it is easy to take out complete specimens.

Remarks: Andaman and Nicobar Islands are well known for the holothurians which are used for *Bêche-de-mer* (James 1983b, 1987). Panning (1944) lists *Holothuria (Acanthotrapeza) pyxis* under the species used for *Bêche-de-mer.* Due to its large size and thick body wall, this species should be well suited for *Bêche-de-mer* preparation. However, the potential of this species for *Bêche-de-mer* industry remains to be exploited.

Subgenus *Platyperona* Rowe, 1969

Diagnosis: Tentacles 18-20; pedicels crowded, irregularly arranged except in smaller specimens where they appear to be arranged in three distinct bands on the flattened ventral surface, papillae small, irregularly arranged on the arched dorsal side, a distinct 'collar' of papillae present around the base of the tentacles; body wall soft, not very thick, usually 2 (1-5) mm; body with a distinct flattened ventral 'sole', arched aborally; size small to moderate, up to 200 mm long; calcareous ring stout, radial plates about twice as long as the interradial plates; spicules consisting of well-developed tables, the disc smooth, round and flat, with a varying number of peripheral holes, spires of moderate height, ending in several spines, the buttons oval, thin, flat, very rarely with a few median knobs, a median longitudinal ridge is apparent with three to six pairs of relatively small holes.

Type species: *Holothuria difficilis* Semper; designated by Rowe, 1969: 143. Three species are included under this subgenus of which one was collected and is presented in this work.

Holothuria (Platyperona) difficilis (Semper)

Holothuria difficilis Semper, 1868, p. 92: Samoa; Koehler & Vaney, 1908, p. 6: Andamans.

Microthele difficilis A.M. Clark & Davies, 1966, p. 600: Maldives; James, 1969, p. 61: Lakshadweep; Nagabhushanam & Rao, 1972, p. 291: Minicoy Atoll (Lakshadweep).

Holothuria (Platyperona) difficilis Mary Bai, 1980, p. 12; Mukhopadhyay & Samanta, 1983, p. 303: Lakshadweep; Soota, Mukhopadhyay & Samanta, 1983, p. 512: Camorta

(Nicobar); Price & Reid, 1985, p. 5: Sri Lanka; James, 1986a, p. 585: Maldives-Lakshadweep, Sri Lanka; James, 1989b, p. 125: Chetlat, Kiltan, Amini (Lakshadweep).

Material: Chetlat, several specimens; Amini, Several specimens; Minicoy, two specimens; all collected under stones.

Description: Length varies from 60 mm to 180 mm. Ventral side well demarcated from the dorsal.

Papillae scattered on the dorsal side without any arrangement. Pedicels arranged in three bands on the ventral side.

The calcareous ring is of the usual type. The radials have a deep notch at the anterior end a slight concavity at the posterior end. Interradials rectangular with an anterior knob-like projection. Polian vesicles two in number and the stone canal is single. Left branch of the respiratory tree is much longer than the right. Cuvierian tubules thick.

Spicules (Fig. 2, C) consist of table and buttons. Tables short and robust. Spire with four rods and numerous teeth at the top. Discs of the tables either round or squarish, with usually eight peripheral holes and one large central hole. Frequently there are several small accessory holes. The diameter of the table disc is 0.08 mm to 0.09 mm. Buttons large, smooth and vary considerably in size, the average length being 0.1 mm. They are broadly elliptical with six or eight small holes. An apparent median longitudinal ridge is present for each button. The number of holes on each side of the button sometimes varies.

The colour in the living condition is light brown with dark brown blotches. The posterior end is tapering. The ventral side is thickly distributed with pedicels which are yellowish-brown in colour.

Distribution: It is known from the islands of Western Indian Ocean, Mascarene Islands, Red Sea, Maldives, Lakshadweep, Sri Lanka, Bay of Bengal, East Indies, North Australia, Philippines, Japan, South Pacific Islands and the Hawaiian Islands. James (1969) reported this species for the first time from the Lakshadweep.

Subgenus *Thymiosycia* Pearson, 1914

Diagnosis: Tentacles 18-20; pedicels and papillae usually irregularly arranged ventrally and dorsally, respectively; anal papillae more or less apparent, a 'collar' of papillae usually present around the base of the tentacles; body wall not very thick, usually 2 (1-5) mm; body vermiform; size small to moderate, up to 200 mm (rarely 250 mm) long; calcareous ring stout, radial plates up to three times the length of interradial plates; spicules consisting of fairly stout tables, the flat disc is squarish or irregular in outline, rarely reduced, usually with 8-10 peripheral holes, the spire of moderate height, ending in a cluster of small spines, the buttons regular or irregular in outline with three or more pairs of comparatively large holes (except in *H. (Thymiosycia) arenicola* which has comparatively small holes), not flattened, lacking any appearance of having median longitudinal ridge, rarely buttons present with slight nodules or forming hollow fenestrated spheres.

Type species: *Fistularia impatiens* Forskaal, 1775; designated by Pearson, 1914: 164).

Remarks: *Brandtothuria* Deichmann 1958, becomes a junior subjective synonym of *Thymiosycia* since its type species, the circumtropical *H. arenicola* Semper, according to Deichmann, is congeneric and consubgeneric with *Fistularia impatiens* Forskaal, the type-species of *Thymiosycia* according to Rowe (1969).

Thirteen species are included under this subgenus. Rowe (1969) is of the opinion that all the nominal species included under the subgenus *Thymiosycia* are not valid. From the Seas around India, five species are known. Three species were collected and included in this work.

KEY TO SPECIES OF THE SUBGENUS

1. Spicules: only tables present . . . . *H. (Thymiosycia) aphanes* Lampert, 1885
1'. Spicules: tables and buttons present 2
2. Spicules: tall spired tables and six-holed buttons present . . . . *H. (Thymiosycia) remollescens* Lampert, 1885
2'. Spicules: spires of tables not tall 3
3. Spicules: buttons with small holes . . . . *H. (Thymiosycia) arenicola* Semper, 1868
3'. Spicules: buttons with large holes 4
4. spicules: tables stout with cluster of short spines at the top . . *H. (Thymiosycia) impatiens* (Forskaal, 1775)
4'. Spicules: tables not stout and with a few spines at the top . . . . *H. (Thymiosycia) hilla* Lesson, 1830

Holothuria (Thymiosycia) arenicola Semper
(Fig. 2, D)

Holothuria maculata Bell, 1888, p. 837: Gulf of Mannar; Koehler & Vaney, 1908, p. 11: North Andamans.

Holothuria (Thymiosycia) arenicola Mary Bai, 1980, p. 12; James, 1983a, p. 96; Soota, Mukhopadhyay & Samanta, 1983, p. 514: Neil Island (Andamans); James, 1986a, p. 585: Lakshadweep-Maldives; James, 1989b, p. 125: Chetlat, Kadmat, Amini, Androth (Lakshadweep).

Material: Port Blair (Andamans), several specimens; Chetlat, four specimens; Kadmat, two specimens; Amini, one specimen; Androth, one specimen; all of them found buried in sand.

Description: Length 30 mm to 200 mm. Body slender and vermiform. Mouth small and surrounded by tentacles ventrally. Dorsally, there are a few papillae. Pedicels small and not conspicuous and arranged in three bands ventrally. Midventral band not distinct. In the other two bands there are 3 or 4 pedicels arranged in a row. Anus terminal and surrounded by five groups of four to six short papillae.

The calcareous ring consists of ten pieces, of which the radials are distinctly longer than the interradials. There is a single large polian vesicle and a single stone canal. The gonads are situated in a single tuft on the left side of the mesentery. The respiratory trees are long and much branched.

The spicules (Fig. 2, D) consist of tables, buttons and supporting plates. Buttons smooth and regular with six holes with edges regularly indented between each pair of holes. Sometimes there are two holes on one side and three on the other side. Buttons numerous in the body wall varying in length from 0.065 mm to 0.069 mm, and from 0.030 mm to 0.032 mm in width. Disc of the table with smooth border and quadrate-circular outline. A large hole at the centre and a small hole at the base of each spire. Peripheral holes vary in number from four to ten. Spire made up of four rods, one cross beam and a crown ending in 10 to 20 teeth. Diameter of the disc varies from 0.056 mm to 0.061 mm, and the length of the spire is about 0.041 mm. Supporting rods of the pedicles smooth, dilated at the ends and in the middle where three to five perforations are present. In the middle generally there are two or three oval holes. The length of the supporting rods varies from 0.18 mm to 0.21 mm.

In the living condition, the general colour of the body is white. On the dorsal side, there are three pairs of reddish-brown spots which are of different sizes. The dorsal side is also scattered with very small brown dots which are not conspicuous. The ventral side is uniformly white. In large forms (200 mm in length) there are ten pairs of reddish brown spots. The spots in the middle region are big. In smaller forms (60 mm in length) there are only three pairs of spots. In one specimen there is a light brown ring round the cloaca. In very small forms (30 mm length) the colour is light brownish-yellow with a few irregular light brown blotches. The colour of the spots varies a great deal and Deichmann (1958) has stated that it depends on the colour of sand or mud in which they live.

Notes on habits: This is a fairly common holothurian at Port Blair and also at

Lakshadweep. It is an inactive holothurian, often completely buried in sand. At Chetlat, when the tide receded small holes were seen on the sand through which water was gushing out. This is caused by this species. It is almost impossible to take out the specimen completely. The moment we dig they go deeper into sand, and lower down there are big stones which make digging difficult. The pedicels and papillae are highly reduced, therefore the burrowing must apparently be effected only by the contraction of the body muscles. In one of the specimens, a small Carapid fish *Echeliophis (Jordanicus) gracilis* (Bleeker) was found. The details of this association are given by James (in press). Mukerji (1932) gave an account of the fishes associated with holothurians from the Andamans. Arnold (1953) presented some observations on the habits of *Carapus acus*. Jones and Kumaran (1980) reported three species of Carapids from *Bohadschia marmorata*.

Distribution: It is a tropical species from the West Indies, Red Sea, Zanzibar, Mascarene Islands, East Indies, Philippines, Southern Japan, Fiji, Hawaii, Tahiti, Galapagos, Cocos Island and eastern coast of Australia. James (1989b) reported this species for the first time from Lakshadweep.

Holothuria (Thymiosycia) impatiens (Forskaal)

(Fig. 2, E & F)

Fistularia impatiens Forskaal, 1775, p. 121.

Holothuria impatiens Bell, 1887a, p. 140: Andaman Island; Bell, 1887b, p.654: Ceylon (Sri Lanka); Ludwig, 1887, p. 1226: Ceylon (Sri Lanka); Bell, 1888, p. 389: Tuticorin (Gulf of Mannar); Koehler & Vaney, 1908, p. 8: Andaman Islands, Great Cocos Island, Point Galle (Sri Lanka); A.M. Clark & Davies, 1966, p. 599: Maldives; James, 1969, p. 61: Red Sea, Lakshadweep, Andamans; Nagabhushanam & Rao, 1972, p. 290: Minicoy Atoll (Lakshadweep); James, 1982, p. 5; James, 1983b, p. 98: Andamans; Tikader & Das, 1985, p. 99: Andaman & Nicobar Islands.

Holothuria impatiens var. *bicolor* James, 1969, p. 61: Port Blair (Andamans).

Holothuria (Thymiosycia) impatiens Mukhopadhyay & Samanta, 1983, p. 307: Lakshadweep; Soota, Mukhopadhyay & Samanta, 1983, p. 514: Corbyn's Cove, Havelock Island, Katchal Island, Curlew Island, Trinket Island (Andamans); James, 1986a, p. 585: Lakshadweep-Maldives, Sri Lanka, Andaman-Nicobar Islands; James, 1989b, p. 125: Chetlat, Kiltan, Kadmat, Amini, Agatti, Kalpeni, Minicoy (Lakshadweep).

Material: Port Blair (Andamans), several specimens; Chetlat, two specimens; Kiltan, two specimens; Kadmat, one specimen; Amini, two specimens; Agatti, one specimen; Kalpeni, two specimens; Minicoy, three specimens (Lakshadweep); all specimens collected in the intertidal region under coral stones.

Description: Length from 60 mm to 240 mm. Body bottle-shaped with a long 'neck'. Superficially the body cannot be differentiated dorsally and ventrally. Mouth and anus terminal. Tentacles about 20 crowded around the small mouth. Body surface covered by well developed papillae placed on low, round warts which are conspicuous by their lighter colour than the rest of the body. Papillae scattered fairly evenly over the surface and not in series. Skin unusually sandy to touch.

Radial (Fig. 2, E) pieces of the calcareous ring much larger than interradials and project forward. The rounded margins have a deep concavity. Interradial pieces with short teeth. A single stone canal and one or two polian vesicles. Cuvierian tubules occur in relatively large bunches. Respiratory trees slender with a few branches. Longitudinal muscle bands very thick.

Spicules (Fig. 2, F) consist of tables, buttons and supporting plates. Tables arranged in a crowded manner with the edges of the discs touching or overlapping each other on the outer layer. Each table consists of four upright rods and two cross beams. Spire robust and the top of the spire with a number of teeth which are level with the upper cross beam. Disc subquadrate usually provided with nine holes forming three rows, central hole larger than the other holes. Diameter of the table discs *c.* 0.10 mm. Spire 0.09 mm high and 0.05 mm in diameter. Buttons oval in shape with mostly three pairs of holes, smooth and with slightly undulating margins and obtuse ends. Very rarely, with more than three holes on each side. Length of the buttons varies from 0.084 mm to 0.10 mm, and breadth from 0.040 mm to 0.049 mm. Supporting rods slightly curved. Central portion dilated like a ring and has invariably two holes. Tips slightly expanded and provided with one to four holes which are generally smaller than those found at the middle. Sometimes the tips of the rods in the papillae are not perforated.

In the living condition, the general colour of the body is light brown with 4 to 5 dark brown transverse bands on the dorsal side at the anterior end. A few dark brown blotches are also found on the dorsal side on the rest of the body. The ventral side is uniformly light brown with three dark bands of the dorsal side extending to the ventral side near the anterior end. In young forms (70 mm length) there are about eight pairs of chocolate brown round blotches, distinct only in the young. The specimen referred to as *Holothuria impatiens* var. *bicolor* by James (1969) has a dark purple body with yellow papillae.

Notes on habits: This is one of the commonest holothurians found around Port Blair. It is a secretive form found under dead coral stones. Often, two or three specimens are found under the same stone. It occurs together with *Holothuria (Thymiosycia) hilla.* On disturbing the animals, thick Cuvierian tubules are released. It is an active holothurian unlike *Holothuria (Thymiosycia) arenicola*, which is very inactive.

Distribution: It is known from the islands of the Western Indian Ocean, Mascarene Islands, East Africa, Red Sea, South East Arabia, Persian Gulf, Maldives, Sri Lanka, Bay of Bengal, East Indies, North Australia, Philippines, Japan, South Pacific Islands, Hawaii and China. James (1969) reported this species from Lakshadweep for the first time.

Holothuria (Thymiosycia) hilla Lesson
(Pl. 1, D; Fig. 2, G & H)

Holothuria hilla Lesson, 1830, p. 266; James, 1969, p. 61: Minicoy, Port Blair; Nagabhushanam & Rao, 1972, p. 290: Minicoy Atoll.

Holothuria monocaria Bell, 1887a, p. 140: Andaman Islands; Ludwig, 1887, p. 1224: Ceylon (Sri Lanka); Bell, 1888, p. 385: Gulf of Mannar; Pearson, 1903, p. 201: Ceylon (Sri Lanka); Koehler & Vaney, 1908, p. 11: Laccadives(Lakshadweep), Mergui Archipelago, Andamans, Persian Gulf; Gravely, 1927, p. 164; A.M. Clark & Davies, 1966, p. 603: Maldives; James, 1969, p. 62: Gulf of Mannar, Andamans, Lakshadweep; Daniel & Haldar, 1974, p. 428: Lakshadweep & Maldives; Satyamurti, 1976, p. 47: Shingle Island (Gulf of Mannar); James, 1988b, p. 404: Gulf of Mannar.

?*Holothuria ondaatjei* Bell, 1887b, p. 654: Ceylon (Sri Lanka).

Holothuria (Thymiosycia) hilla Mukhopadhyay & Samanta, 1983, p. 307: Lakshadweep; Soota, Mukhopadhyay & Samanta, 1983, p. 519: Andaman & Nicobar Islands; James, 1986a, p. 585: Lakshadweep-Maldives, Gulf of Mannar-Palk Bay, Sri Lanka, Andaman & Nicobar Islands; Mukhopadhyay, 1988, p. 8: Pulli, Krusadai, Vedalai, Mandapam Camp, Tuticorin (Gulf of Mannar); James, 1989b, p. 126: Chetlat, Bitra, Kiltan, Kadmat, Amini, Minicoy (Lakshadweep).

Material: Mandapam (Gulf of Mannar), 1 specimen; Tuticorin (Gulf of Mannar), Port Blair (Andamans), several specimens; Chetlat, several specimens; Bitra, two specimens; Kiltan, several specimens; Kadmat, three specimens; Amini, two specimens; Minicoy, two specimens; all collected from the intertidal region under coral stones.

Description: Length from 50 mm to 200 mm. Body long and cylindrical with blunt ends. Body wall soft. Dorsal and ventral sides demarcated in the living condition. Papillae sparsely arranged and have expanded bases. Ventral side has numerous pedicels arranged in three rows. A small space at the anterior end near the collar is free from pedicels. Each band of pedicels with five or six tubefeet arranged side by side. Mouth surrounded by 20 inconspicuous papillae. Tentacles small. Ten anal papillae.

The calcareous ring is of the usual type with the radials longer than the interradials (Fig. 2., G.). The right respiratory tree is long, extending up to the anterior end, while the left one is shorter and joins the viscera. Cuvierian tubules are present though not abundant. In a specimen dissected, two polian vesicles and a single stone canal were present.

Spicules (Fig. 2, H) consist of tables and buttons. Tables possess smooth rounded discs. Four large holes corresponding to the four spires in addition to about fifteen peripheral holes. Spire of the tables consists of four pillars and one cross beam which terminates in twelve or more teeth. Buttons oval, smooth and symmetrical with three or four pairs of holes. Holes at either end generally elongate. Length of the buttons varies from 0.17 mm to 0.28 mm. Diameter of the disc tables varies from 0.031 mm to 0.038 mm. In young specimens (60 mm in length), the tables have slightly undulating margins. The papillae have rudimentary terminal plates and curved rod-like perforated spicules.

In living condition, small specimens are chocolate brown in colour and large specimens are golden brown with a circular pale area around the appendages.

Notes on habits: This too is one of the commonest holothurians around Port Blair. It is a fugitive species always found under coral stones. Often two or three specimens are found under the same stone along with *Holothuria (Thymiosycia) impatiens.* One of the specimens collected at Port Blair had a Carapid fish *Encheliophis vermicularis* at the base of the respiratory tree. The behaviour of this fish is similar to the fish *Encheliophis* (*Jordanicus*) *gracilis* collected from *Holothuria (Thymiosycia) arenicola* (James, in press).

Distribution: It is known from the islands of the Western Indian Ocean, Mascarene Islands, East Africa, Red Sea, South East Arabia, Persian Gulf, Maldives, Sri Lanka, Bay of Bengal, East Indies, North Australia, Philippines, Japan, South Pacific Islands, Hawaiian Islands and China.

Subgenus Mertensiothuria Deichmann, 1958

Diagnosis: Tentacles 18-20; pedicels crowded, in smaller forms arranged in three distinct rows ventrally, papillae small, irregularly arranged dorsally, anal papillae or 'collor' or papillae around the base of the tentacles not apparent; body wall variable, soft, ranging from thin to fairly thick, usually about 2-3 (1-4) mm; body almost cylindrical but with a more or less flattened ventral 'sole'; size moderate to large (up to 250 mm long); calcareous ring stout with radial plates about twice as long as the interradial plates; spicules consisting of not very strongly developed tables with the rim of the disc usually spinose and the spire low, ending in a ring or cluster of spines, the tables occasionally degenerate or incomplete, buttons irregular, usually with three pairs of holes, sometimes incomplete.

Type species: *Stichopus leucospilota* Brandt, 1835; designated by Deichmann, 1958.

Under this subgenus, six species are included. Three of the species are known from the seas around India, and have been collected and described in this work.

KEY TO THE SPECIES OF THE SUBGENUS

1. Spicules in inner layer resembling narrow rosettes . . . . . . *H. (Mertensiothuria) pervicax* Selenka, 1867

1'. Spicules in inner layer, buttons either complete or incomplete 2

2. Buttons mostly two slit-like holes and one or two smaller pairs of holes at either end . . . . *H. (Mertensiothuria) fuscocinerea* Jaeger, 1833

2'. Buttons delicate, mostly with large holes, often narrow . . *H. (Mertensiothuria) leucospilota* (Brandt, 1835)

Holothuria (Mertensiothuria) pervicax Selenka (Fig. 2, I)

Holothuria pervicax Selenka, 1867, p. 327: Zanzibar; A.M. Clark & Davies, 1966, p. 600: Maldives; James, 1969, p. 61: Lakshadweep.

?*Holothuria exilis* Koehler & Vaney, 1908, p. 14: Andaman Island.

Holothuria (Mertensiothuria) pervicax James, 1986a, p. 585: Lakshadweep-Maldives, Sri Lanka, Andaman-Nicobar Islands; James, 1989b, p. 126: Chetlat, Minicoy (Lakshadweep).

Material: Chetlat, one specimen; Minicoy, two specimens; Port Blair (Andamans), one specimen; all collected from intertidal region under coral stones.

Description: The specimens examined ranged in length from 70 mm to 120 mm. They are subcylindrical in shape. The dorsal and ventral sides are well differentiated. On the ventral side there are a number of pedicels arranged closely without any evidence of band formation. The papillae are scattered on the dorsal side. The tentacles are definitely ventral in position. Cuvierian tubules are thick.

Calcareous ring is of the usual type. There is a single large polian vescicle and a single stone canal.

Spicules (Fig. 2, I) consist of incomplete and oblong rods with lateral projections resembling narrow rosettes. The disc of the table is usually subcircular. Each disc has a fairly big hole at the base of each slender spire. Frequently supplementary holes are also present. The edge of the disc is smooth. The diameter of the discs varies from 0.03 mm to 0.05 mm. The spire has a cross beam and is frequently incomplete and ends in four simple teeth. In some cases, the spire is rudimentary and the crowns have no transverse pieces. The rosettes vary in size from 0.023 mm to 0.069 mm in length. They are irregular and smooth. The pedicels have well developed plates, but in the papillae they are rudimentary. The pedicels and papillae, in addition to long curved rods with short irregular processes, have bilateral fenestrated plates. These plates vary in length from 0.30 mm to 0.36 mm. Those plates which are in the neighbourhood of the terminal plates of the pedicels are formed by the branching and joining of the lateral processes of the supporting rods.

In the living condition, the dorsal side is brown in colour with 5 to 7 honey coloured transverse bands of different widths. The ventral side is lighter, mottled with white and light violet on a brown background. The cloacal opening is surrounded by a dark violet ring with some portion of the inner cloacal wall of the same colour.

Remarks: This is a rare species, both at Lakshadweep and the Andamans.

Distribution: It is known from the islands of the Western Indian Ocean, Mascarene Islands, East Africa, Red Sea, South East Arabia, Maldives, Sri Lanka, East Indies, North Australia, Philippines, South Pacific Islands and Hawaiian Islands. It was reported for the first time from Lakshadweep by James (1969). James (1986a) also reported this species for the first time from the Andaman and Nicobar Islands.

Holothuria (Mertensiothuria) fuscocinerea Jaeger (Fig. 2, J)

Holothuria fuscocinerea Jaeger, 1833, p. 22: Celebes; Ludwig, 1887, p. 1227: Ceylon (Sri Lanka).

Holothuria curiosa Pearson, 1910, p. 188: Mergui Archipelago.

Holothuria (Mertensiothuria) fuscocinerea Mukhopadhyay & Samanta, 1983, p. 304: Lakshadweep; James, 1986a, p. 585: Sri Lanka and Andamans.

Material: Port Blair (Andamans), one specimen, collected under coral stone in the intertidal region.

Description: The length of the specimen is 120 mm. The body is long and tubular with 20 large ventral tentacles. Tentacles on the ventral side are arranged in three, though not distinct bands The papillae on the dorsal side are scattered. There is a single polian vesicle and a large stone canal. Cuvierian tubules are large.

In the specimen examined only buttons (Fig. 2, J) were noticed. Buttons are small and often incomplete. Usually each button has two narrow slit-like holes and one or two pairs of minute holes at each end. The length of the buttons varies from 0.01 mm to 0.04 mm.

Colour in the living condition is brownish, more or less mottled, Ventral side is pale grey.

Distribution: It is known from Sri Lanka, Philippines, Celebes, Fiji, Samoa, Australia and Japan. James (1986a) recorded it for the first time from the Islands.

(*to be continued*)

ECOLOGY OF POLLINATION IN TWO CAT-MINT SPECIES[1]

Raju J.S. Aluri and C. Subba Reddi[2]

Key words: *Anisomeles,* pollination, carpenter bees, sunbirds

The herbaceous perennials, *Anisomeles malabarica* and *A. indica* grow from perennating root stock and seed. *A. indica* produces flowering episodes in correspondence with water-saturation of the soil while *Anisomeles malabarica* does not. The floral morphology and pollination mechanism of the two species are similar. The plants resort to self -pollination shortly before flowers turn disfunctional in the absence of pollinators. Both plants are nototribically pollinated by some species of carpenter bees and sunbirds during probing for floral forage. The pollinators by their forage collecting behaviour coupled with territorial and traplining behaviour greatly augment cross-pollination in the plants. The data presented in the paper are valuable for commercial breeding.

Introduction

The Asian-Australian genus *Anisomeles* belongs to the tribe Lamieae of the subfamily Lamiodeae (Abu-Asab and Cantino 1987) and is taxonomically characterised by glandular-hairy floral parts, and upper pair of stamens with 1-celled anthers and a lower pair with 2-celled anthers. The essential floral parts always extend dorsally in the corolla tube, proximate to or along the upper corolla lip, and not along the lower lip as in the subfamily Ocimoideae. Except for a small note on the flower morphology and foragers of *Anisomeles indica* by Burkill (1916), there is no information on the details of ecological aspects of pollination in the genus *Anisomeles*. The pollination biology data are required to understand sexual reproduction and perpetuation of weedy species.

The paper describes ecological aspects of pollination in *Anisomeles indica* and *Anisomeles malabarica* in India. The investigation was made with a view to provide information on pollination of the plants for extensive commercial uses.

Observations

1. Plant and flowering phenology

Anisomeles malabarica grows in disturbed and undisturbed areas with soils saturated and unsaturated, while *Anisomeles indica* is confined to undisturbed areas with only water-saturated soils on foot hills of Nallamalai range near Turimella (15° 10' and 16° 18' N, 78° 45' and 79° 34' E) of Prakasam district of Andhra Pradesh, India. The two species are herbaceous perennials and grow from perennating root stock and seed. The perennial root stock produces rapidly growing and early flowering plants, while plants that develop from seed appear later and flower later. *Anisomeles malabarica* starts vegetative growth with the first rains of the monsoon and continues until flowering is initiated. The plant can extend vegetative growth beyond flowering. The plant commences vegetative growth in July, flowers in mid-October and disappears in January.

Anisomeles indica primarily inhabiting stream edges does not show vegetative growth following first rains. Streams in this area are rain-fed and used for irrigating local farmlands through regulation of water flow by diverting excess water into reservoirs. The plant begins

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[1] Accepted November 1992.

[2] Department of Environmental Sciences, Andhra University, Waltair 530 003.

vegetative growth only when the soil is water-saturated. The water-saturation of the soil of the area depends on water flow in streams. The vegetative growth and flowering of the plant fall during the period from October to mid-January. The plant exhibits flowering episodes in response to the water content of the soil where it grows.

2. The Flower

The flower details of the two *Anisomeles* species are similar to each other. The purple and fragrant flowers are borne in verticils on the stem. Within a verticil the flowers are arranged in rings. New flowers open daily from each verticil and each flower lasts 2 days. The flowers are gullet type and distinctly bilabiate with a small upper lip and a broad expanded lower lip. They have a basal corolla tube containing a good amount of nectar (1.6-1.8 μl) having 32-48% sugar concentration and protected from unwelcome foragers by a ring of hairs from the base of the flowertube at the point where the stamens are inserted. The anthers which dehisce prior to anthesis are oriented downward at the upper lip of the corolla, thereby brushing pollen onto the anterior dorsal part of the flower. The bilobed stigma protrudes little beyond the anthers. The spreading lower lip acts as landing place for the insect foragers.

The sugar composition of the two *Anisomeles* species nectar determined by paper chromatography indicated presence of glucose, sucrose and fructose.

3. Pollination

Anisomeles malabarica antheses during the night from 0100 to 0500 hr and *Anisomeles indica* in the early morning from 0530 to 0730 hr, the flowers of both are available for day-time foragers. The flowers are foraged by day-flying bees, wasps, ants, thrips, butterflies and sunbirds. The foragers seem attracted to the purple colour of the flowers with sweet fragrance, ample pollen and copious nectar. Of these, only carpenter bees and sunbirds are regular and perform effective and efficient pollination. The other foragers occasionally visit the flowers and some of them deplete floral forage by probing from the side of the flowers bypassing the pollination apparatus. The carpenter bees after landing on the strong lower lip probe flowers nototribically in upright position for nectar during which the stigma situated near the tip of the upper lip contacts the residual pollen in the dorsal cervical crevice of the bees.

The bees exhibit territorial foraging behaviour defending selected plant populations of *Anisomeles* from intruders depleting floral forage by remembering space constellations and images of the region. The bees also display trap-lining behaviour by foraging on discontinuously stretched flowering *Anisomeles* in a selected region visited on their regular rounds. The dual foraging behaviour displayed by carpenter bees greatly profit the plants in outcrossing.

Sunbirds are as regular and effective as carpenter bees in performing the pollination in *Anisomeles* species. They forage for nectar in the flowers from the front in vertical position. Their foraging for the hidden nectar through the protective ring of floral hairs near the staminal base results in the contact of the bilobed stigma and the anthers with the bill and forehead of the birds. The *Anisomeles* species are used as feeding stations by the birds throughout the winter season. There are no other species of flowers and the birds totally rely on *Anisomeles* flowers for food source.

The flowers of both species resort to self-pollination by reflecting the stigmatic lobes striking the powdery pollen in the anthers below.

This physiological movement of the stigma occurs shortly before the stigma turns brown and becomes dry. The auto-pollination occurs only in those flowers which have not been visited by foragers of any kind.

Discussion

Since the two *Anisomeles* species are herbaceous perennials, they reproduce asexually from perennating root stock and sexually by seed. Sexual reproduction of the plants involves seasonal or timely production of flowers coinciding the availability of pollinators. Flowering in *Anisomeles malabarica* is independent of water-saturation of the soil after the plant's vegetative growth. In contrast, the flowering on *Anisomeles indica* seems regulated by water quantity of the soil which causes flowering episodes. Attempts to test this phenomenon in a green house by growing this plant experimentally have been made without success. Seeds of this plant did not germinate in different treatments, and it appears that there are unknown barriers for breaking dormancy and subsequent germination (Aluri unpubl. data; Cantino pers. comm.).

The two *Anisomeles* species have a personate floral form with stamens and style extending beyond the upper lip and resulting in the classical gullet type blossom credited for precision and economy in pollen transfer by nototriby. The purple colour of the flowers appears to act as the main attractant coupled with flower density, amplified by patchy distribution of the plants. The purple flowers seem to reflect blue component which the insect foragers can see. Experimental evidence for this phenomenon has been repeatedly shown in the purple flowered *Pedicularis* species which reflect blue component and ultraviolet light and are pollinated by bumble bees (Macior 1968, 1982, 1986a, b, c).

Recorded observations on the foragers of the two *Anisomeles* species suggest that only the carpenter bees and sunbirds are suitable and functional pollinators which orderly and precisely effect pollination by manipulation of the floral mechanism (Proctor and Yeo 1972, Faegri and Van der Pijl 1979). Burkill (1916) also observed carpenter bees as appropriate pollinators of *Anisomeles indica.* Other foragers by their occasional and intra-floral behaviour mainly deplete the floral forage thereby influencing the intensity of foraging visits of the functional pollinators.

The flower form with sexual organs positioned near the upper lip and with the spreading strong lower lip facilitates adequate landing place for the large bodied carpenter bees (*Xylocopa latipes and X. pubescens*). The bees nototribically pollinate the flowers by their probing in upright position dorsally contacting in the cervical crevice region and the anteriorly placed anthers and stigma near the upper lip. Since the plants resort to self-pollination extending the stigmatic lobes into the pollen-laden anthers shortly before the stigma becomes dry and brown in the absence of pollinators, the plants appear to have a preference for cross-pollination. The carpenter bees by their nototribic foraging behaviour and inter-plant and patch movement cross-pollinate the flower. The latter movement of the bees is exhibited in territorial and trap-lining behaviour, both of which are instrumental for effective cross-pollination. Such behaviour of the bees on different plants has been documented by several workers (Pijl 1954, Janzen 1964, Frankie 1976, Barrows 1980, Frankie *et al.* 1983).

The sunbirds also probe the flowers nototribically by landing on internodes of the inflorescence, inserting their bill and forehead into the flower mouth leading to the nectary and contacting the bifid stigma with their pollen-laden posterior edge of the bill and anterior edge of the forehead. The birds do not employ foraging methods exhibited by carpenter bees. They, however, use flowering *Anisomeles* populations as feeding stations and daily forage on the flowers by having nests nearby in the branches of *Euphorbia antiquorum.* The carpenter bees also use the plants of some species for nest-making in the *Anisomeles* growing area. The birds also contribute to active pollen flow for cross-pollination by their regular and effective foraging on the plants within and between patches. Both carpenter bees (*Xylocopa latipes* and *X. pubescens*) and sunbirds (*Nectarinia asiatica* and *N. zeylonica*) are thus equally important for pollen transfer in the two *Anisomeles* species.

The two *Anisomeles* species occupy the same geographic area but separated by habitat. This habitat separation is not instrumental in preventing natural inter-breeding between the two plant species since carpenter bees and sunbirds are long distance flyers and make foraging movements between the two plant species. Such alternate foraging of the pollinators is likely to result in inter-breeding provided that the genomes of the plants are compatible for crossing.

Field surveys in the study area indicate that one plant resembles in the vegetative and floral features of both *Anisomeles indica* and *Anisomeles malabarica.* Extensive study is needed to understand how this plant has resulted. Attempts are being made to test this by hybridization raising the plants from the seeds fed with its natural soil in a green house. If the results indicate viable and vigorous hybrids, the data would then form a basis for further studies on commercial lines.

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A STUDY OF ABNORMAL NESTS OF BAYA WEAVER BIRD *PLOCEUS PHILIPPINUS* (LINN.) IN RAJASTHAN[1]

SATISH KUMAR SHARMA[2]

(*With six text-figures*)

Key words: abnormal nests, monostoreyed nests, multistoreyed nests, symmetry, simple harmonic motion, storeyfication, nest fusion

The Baya Weaver Bird *Ploceus philippinus* (Linn.) is a colonial nester. Besides normal nests, various types of abnormal nests are fabricated by cocks during breeding period. Many abnormalities can be seen in nests of Bayas, either structural or orientational or both. Keeping abnormalities in view, as many as 16 types of abnormal nests were observed in Rajasthan. There is a trend towards bistoreyed nests followed by fused nests.

This paper describes a field study of various qualitative and quantitative aspects of abnormal nesting in sexually mature male Baya weaver bird *Ploceus philippinus* (Linn.). Besides a few stray notes and papers that had appeared in various journals (Jesse 1897, Prater 1932, Ali and Ambedkar 1956, Ambedkar 1964, 1980; Crook 1964, Sharma 1985, 1988; Davis 1985) no systematic study has been done so far on this aspect. Ambedkar (1980) has given a good account of multistoreyed and composite nests. Sharma (1985) gives a detailed account of some qualitative aspects of abnormal nesting in Baya Weaver Bird *Ploceus philippinus* (Linn.).

STUDY AREA

The study was carried out mainly in four districts, namely Alwar, Bharatpur and Jaipur of eastern Rajasthan and Udaipur in southern Rajasthan.

Eastern Rajasthan is a fairly plain area receiving an average annual rainfall of 675 mm. The southern part of the state is hilly and receives more rainfall (up to 1000 mm.).

MATERIALS AND METHODS

A large number of nest colonies of *Ploceus philippinus* (Linn.) were observed in the agricultural fields, ravines, forest fringes and area around water bodies. Abandoned abnormal nests were collected at the end of the monsoon rains when breeding activities of weaver birds come to an end. Parent birds then, leave their nests along with the juveniles. Nests were collected by a bamboo, having sharp hook at its upper end. When nests were beyond reach, their sketches were made on paper or they were photographed at the spot. Internal structure of the nest was examined by bisecting the nests at different planes, using scissors.

GENERAL PLAN OF A NORMAL NEST

A typical completed nest of *P. philippinus* (Linn.) is a bottle shaped structure and can be divided into three parts - stalk, body and entrance tube. A normal completed nest of *P. philippinus* (Linn.) has its entrance tube slightly shifted towards the entrance-hall side due to which more bulging appears towards the egg-chamber. Due to this position of the entrance tube a completed nest can be divided into two equal halves across the chin-strip only, hence

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[1] Accepted December 1992.

[2] Range Forest Officer, Aravalli Afforestation Programme, Jhadol (F.), Udaipur Dist., Rajasthan.

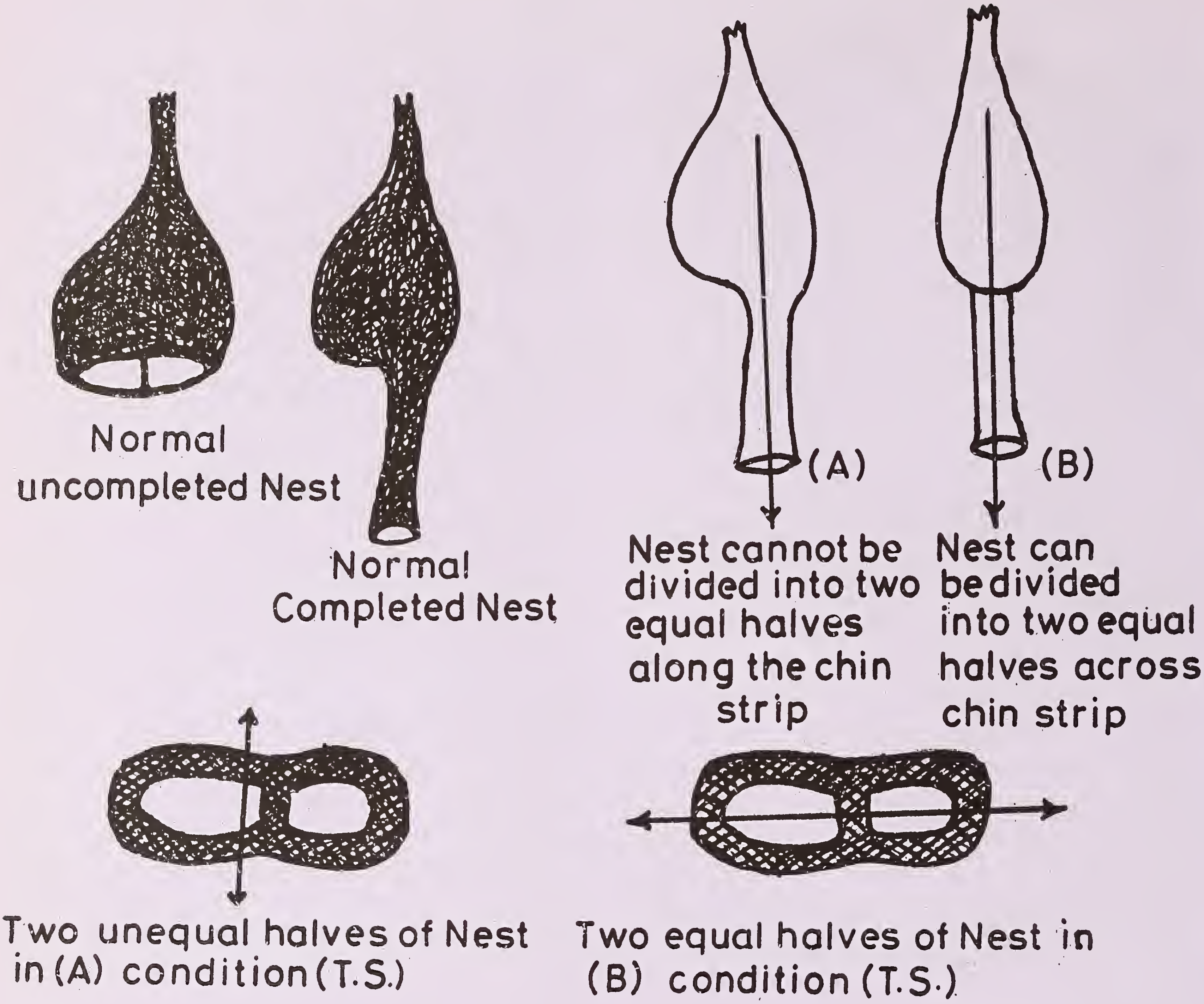

Normal uncompleted Nest
Normal Completed Nest
(A)
(B)
Nest cannot be divided into two equal halves along the chin strip
Nest can be divided into two equal halves across chin strip
Two unequal halves of Nest in (A) condition (T.S.)
Two equal halves of Nest in (B) condition (T.S.)

Fig. 1. Symmetry of normal completed nest at two planes.

they are zygomorphic in terms of symmetry (Fig. 1).

Incomplete nests are precursors of completed nests. They are bell shaped in structure, lacking an entrance tube and the characteristic 'dome' of the egg-chamber (Fig. 2).

Details of structure of normal nests are given elsewhere (Ali 1931, Ali and Ambedkar 1956, 1957; Ambedkar 1958, 1964; Crook 1960, Mathew 1976, Sharma 1985).

QUALITATIVE ASPECTS OF ABNORMAL NESTS

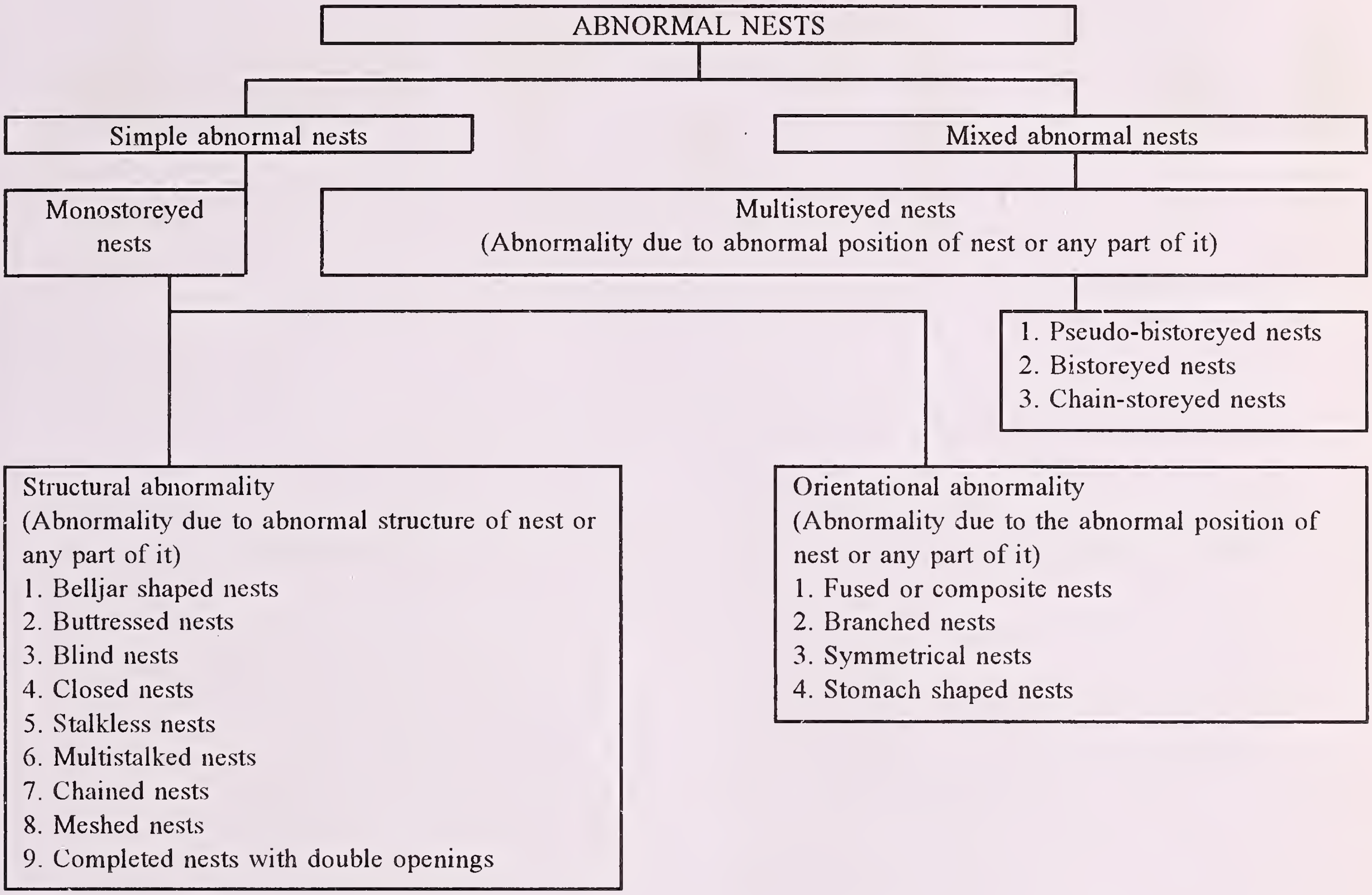
Besides typical nests, which are otherwise called normal nests, various types of abnormal nests are prepared by sexually mature male birds during breeding season. Many variations can be seen in nests of Bayas which make a nest abnormal.

A. Abnormality in structure of nest or any part of it. Abnormal structure(s) may appear due to:

(i) Duplication of part(s), or/and (ii) Formation of additional part(s), or/and
(iii) Elaboration of normal part(s), or/and
(iv) Abolition of normal part(s).

B. Abnormality in position of nest or any part of it.

As indicated above, there may be many kinds of abnormalities. When one type of abnormality is present in nest it may be called a simple abnormal nest and when more than one type of abnormalities appear in it, it may be called mixed or complex abnormal nest.


ABNORMAL NESTS
Simple abnormal nests
Mixed abnormal nests
Monostoreyed nests
Multistoreyed nests
(Abnormality due to abnormal position of nest or any part of it)
1. Pseudo-bistoreyed nests
2. Bistoreyed nests
3. Chain-storeyed nests
Structural abnormality
(Abnormality due to abnormal structure of nest or any part of it)
1. Belljar shaped nests
2. Buttressed nests
3. Blind nests
4. Closed nests
5. Stalkless nests
6. Multistalked nests
7. Chained nests
8. Meshed nests
9. Completed nests with double openings
Orientational abnormality
(Abnormality due to the abnormal position of nest or any part of it)
1. Fused or composite nests
2. Branched nests
3. Symmetrical nests
4. Stomach shaped nests

A simple classification of abnormal nests is given in the diagram.

A. MONOSTOREYED NESTS:

A class of simple nests, much similar to ormal nests in their construction and general plan. Each individual monostoreyed nest possesses only one egg chamber in the only storey-hence monostoreyed. Details of different kinds of monostoreyed nests are given in Fig. 2.

Belljar shaped nests: These are completed nests with very wide entrance tube through out or most of its length. Though lower most part of the entrance tube may become dilated due to continuous clinging on by the bird in normal nests also, but in belljar-shaped nests widening could be seen throughout length of tube. Rather it is structural widening which does not appear due to clinging.

Buttressed nests: In certain cases a mesh of woven fabrics may occur at any angular region of nest. It was noticed that such type of mesh always occurs vertically on the body of the nest,

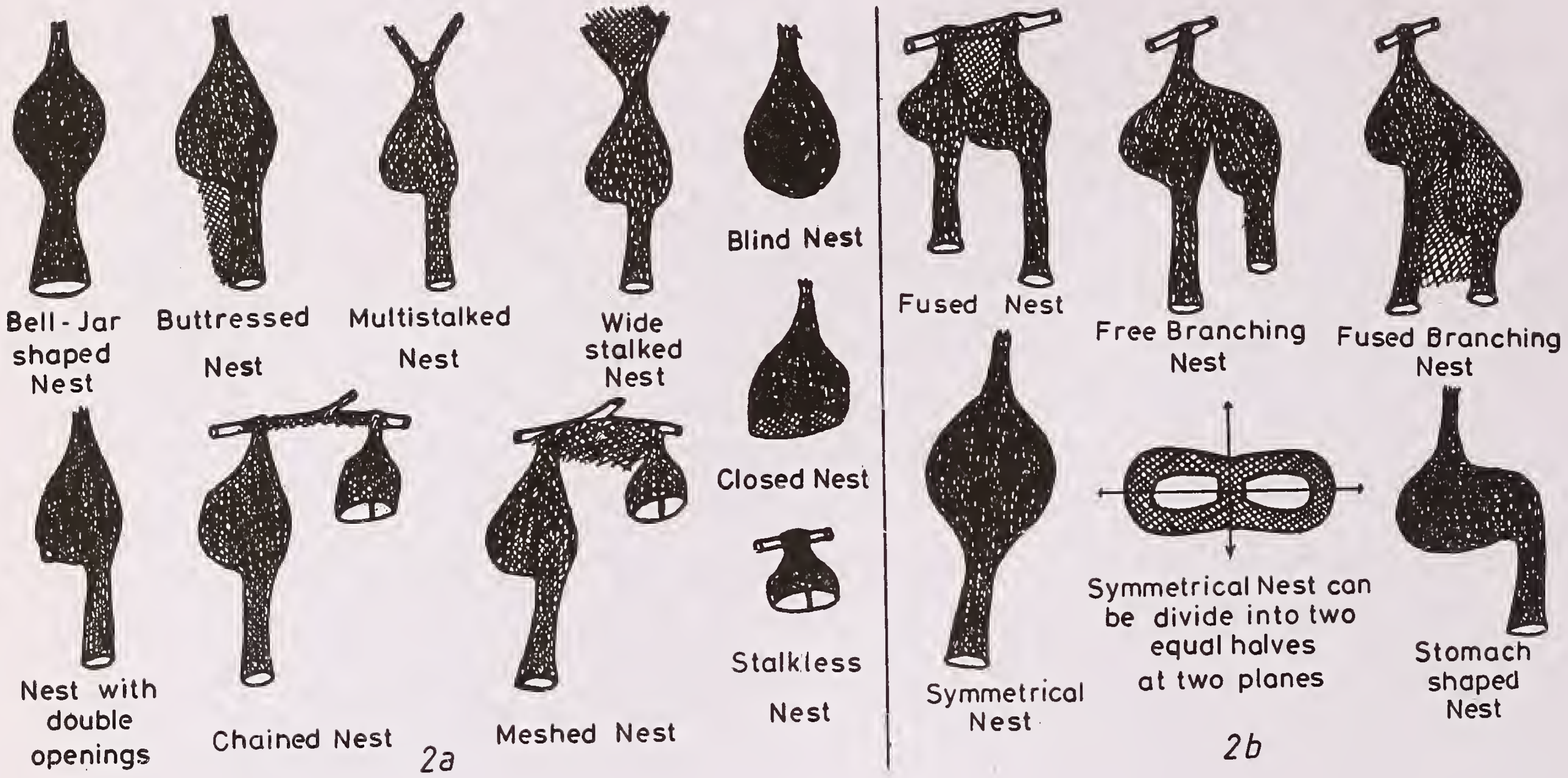

Bell-Jar shaped Nest
Buttressed Nest
Multistalked Nest
Wide stalked Nest
Blind Nest
Closed Nest
Stalkless Nest
Nest with double openings
Chained Nest
2a
Meshed Nest
Fused Nest
Free Branching Nest
Fused Branching Nest
Symmetrical Nest
Symmetrical Nest can be divide into two equal halves at two planes
Stomach shaped Nest
2b

Fig. 2a. Mono-storeyed nests of various kinds with structural abnormalities; 2b. Mono-storeyed nests with orientational abnormalities.

i.e. across the chin strip on either the outer front wall of the egg chamber or the entrance hall. Sharma (1988) has described such nests elsewhere.

Blind nests: Sometimes a denser mesh may occur on both the openings of a half built nest, making it tightly closed. Such nests when viewed externally give no clue of openings. These club shaped nests having a short stalk, look like a spherical mass (Davis 1985).

Closed nests: These are completed or uncompleted nests, which resemble blind nests, but their opening(s) could be traced externally due to the presence of thin mesh over the opening(s).

Stalkless nests: Stalkless nests are fabricated by *Ploceus benghalensis* and *P. manyar* in reeds and grasses. *Ploceus philippinus* is a bird which fabricates stalked nest on trees and high bushes, but in certain cases stalkless nests could be seen in nature. Stalkless nests are hardly ever accepted by female birds, hence they are seldom completed by the cock.

Multistalked nests: In normal cases only one stalk is fabricated by the cock. But, in many cases more than one stalk may occur, hence multistalked nest. The presence of two or more stalks provide extra attachment strength to the nest. Such type of nests are common on *Phoenix sylvestris*. It is the height of the *P. sylvestris* which makes a hanging nest prone to simple harmonic motion on windy days. Hence, to minimize such a pendulous motion more than one pinnae are involved for stalking the nest.

Some times the gap between two stalks is blocked by a woven mesh, due to which a nest becomes 'wide stalked nest'. This device is equally good to minimize the simple harmonic motion.

Chained nests: In normal cases a male bird keeps a distance between two successive nests hanging on the same branch. No physical contact is seen between the nests; but sometimes nests could be joined with a mesh of woven fibres which is fabricated along and around the twig itself. This is the simplest way to join the nests. Actual nests remain normal in structure.

Meshed nests: Often, instead of making a mesh around the twig, it is extended beneath the twig on which nests are hung. This flap like mesh is used to join the down stalk angular point of the top nest with the upper stalk angular point of the lower nest (Sharma 1988).

Completed nests with double openings: Though uncompleted nests always contain two openings, a typical completed nest possesses only one for use. An additional opening with an additional very small tube was seen in a completed nest in 1980 on National Highway 11 near village Hantara in District Bharatpur (unpublished). This particular nest held eggs at the time of observation and double openings were maintained right from the pre-hatching stages, hence the nest was a truly double opening nest.

It was observed that sometimes an additional opening may be created in those nests which have fledglings about to leave the nest. This opening is created near the egg chamber to shorten the length of the entrance tube so that the number of feeding trips could be increased for growing chicks. This is the case where double openings are maintained during the post-hatching stage. Hence such nests are not truly double opening nests.

Fused nests or Composite nests: Distance between two nests, in chained and meshed kind is kept shorter so that they could be linked easily. In both the cases linking is very loose and nests do not come in direct contact. Some times this inter-nest distance is further reduced and two or more successive nests are made side by side in physical contact. Various degrees of fusion could be seen between two closely hanging nests. Their fusion may be partial or total. Actually, a fused nest is an aggregation of parallely fused two or more completed or/and uncompleted nests. It is remarkable to note that the base of the each individual nest of a 'fused complex' has independent attachment on branch(es) of the host tree. Fused nests have been recorded from different parts of the country by Prater (1932) and Ambedkar (1980) also.

Branched nest: In fused nests, all individual nests of a 'fused complex' seek their attachment on twig(s) but this attachment pattern is not followed in a branched nest. In such a nest, besides one (main nest), the side nest(s) commences from any part of the main nest, except from the bottom of the tube. Due to this abnormal hanging pattern of individual nests, a branching nest comes into existence. Branched nests may be of two types:

i) *Free branching nest:* Branches, i.e. side nests are not fused with the main nest.

ii) *Fused branching nest:* Side nests are fused with the main nest. Such nests may be either 'partially fused' or 'totally fused' according to the degree of fusion.

Symmetrical nests: The position of the egg chamber and the entrance hall could be identified in ordinary completed nests due to the position of the entrance tube, which occurs slightly shifted towards the entrance hall side. Not only this, but a greater bulge could be seen towards the egg-chamber half also. Such a nest could be divided into two equal halves from one plane only, i.e. across the chin-strip.

Sometimes the entrance tube is kept exactly centered so that both halves get similar bulges. In such a condition, even an expert could make mistakes in identifying the egg-chamber half externally. Such nest could be divided into two equal halves at two different planes (perpendicular to each other) - across the chin-strip and along the chin-strip; hence such nests are actinomorphic in terms of symmetry.

Stomach shaped nests: In ordinary cases the stalk is seen towards the upper terminal portion of the nest and all the three parts of a completed nest, namely stalk, body and tube remain in a straight vertical line. In stomach-shaped nest, alignment of the nest becomes disturbed and the stalk and the tube take a more or less perpendicular position on the body of the nest. Due to this abnormal position of the stalk and tube a nest looks like a human stomach in appearance - hence stomach shaped nest.

B. MULTISTOREYED NESTS:

A complicated group of nests, generally possessing more than one egg-chamber in a series vertically, and more than one storey built in the same fashion - hence, multistoreyed. Actually a multistoreyed nest is a linear fusion of two or more monostoreyed nests along their vertical axes in a series. Ambedkar (1980) called such nests as 'abnormal multi-chambered linear nest'. Details of multistoreyed nests are given below:

Pseudo-bistoreyed nests: These are completed nests, basically monostoreyed in structure, having one egg chamber like a normal nest; but they present a false appearance of being double egg chambered and double storeyed, externally. Upper storey of such nests having no cavity, i.e. totally solid due to woven mass of fabrics. It is the lower storey which contains egg-chamber in it (see Fig. 3).

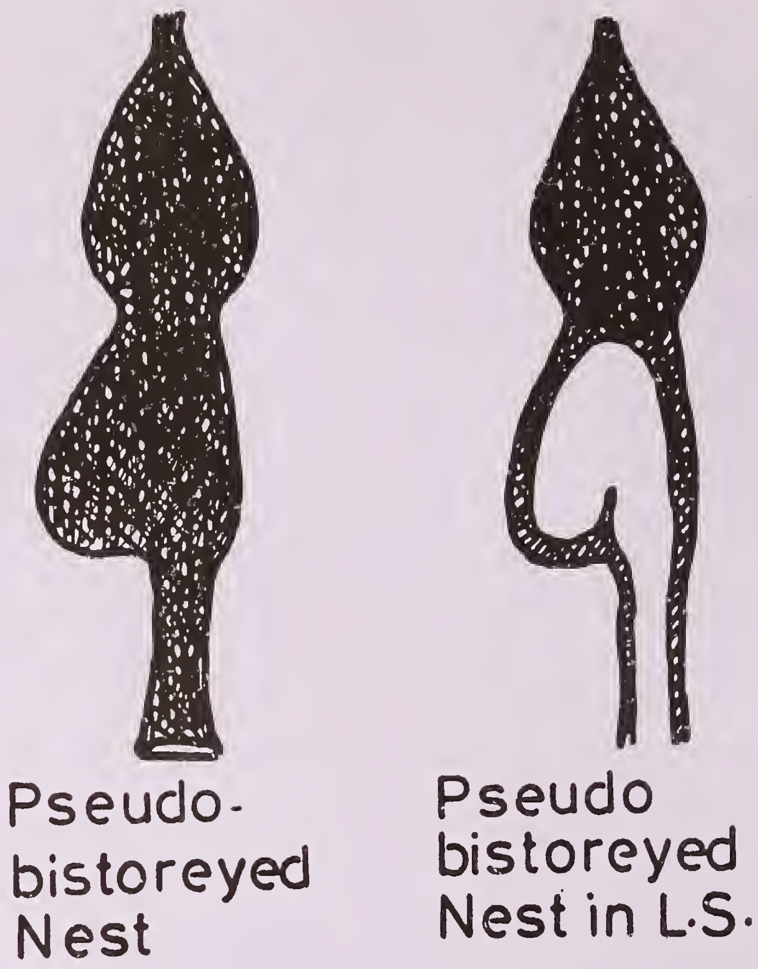


Fig. 3. Pseudo-bistoreyed nest (0 + 1 Storey).

Bistoreyed nests: These are truly bistoreyed, formed by the fusion of two completed or two half completed or one completed and one half completed nest in vertical plane, i.e. along their vertical axes. Such nests having two storeys, have two egg-chambers in reality. In such complicated nests the lower nest commences from the bottom of the entrance tube of the upper nest. In most of the cases the upper storey is useless as the entrance is closed up by the lower nest (see Fig. 4).

[3]**Chain-storeyed nests:** Chain storeyed nests are more complicated than the bistoreyed and are formed when more than two nests are fused along their vertical axes in a series. In Rajasthan state, only three storeyed nests have been observed during the study period so far, though a 'six storeyed' nest had been recorded from Pune by Ambedkar (1980); but in the present classification of abnormal nests, Ambedkar's six storeyed nest will be kept under

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[3] Chain-storeyed nests were described as poly-storeyed nests by Sharma (1985). Because the term multistoreyed and polystoreyed are synonymous hence to differentiate them, term 'chain-storeyed nest' is used for polystoreyed nest in the present paper.

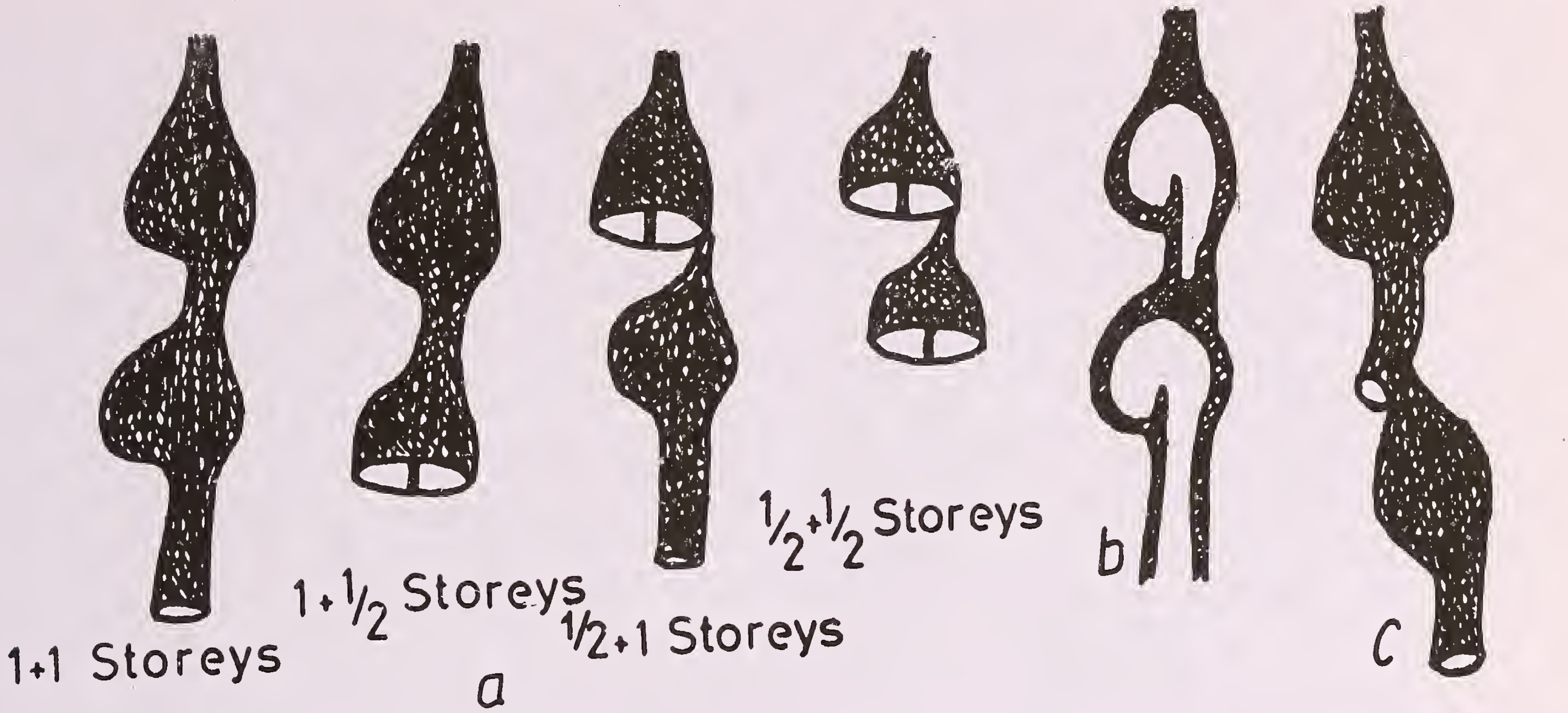


Fig. 4. a. Bistoreyed nests in external appearance; b. A bistoreyed nest in L.S. (upper storey blocked); c. A bistoreyed nest with both the 'alive' storeys.

mixed abnormal group. Chain-storeyed nests have been described by Davis (1985) also.

Various combinations of half built and completed nests are possible in chain storeyed nests (see Fig. 5).

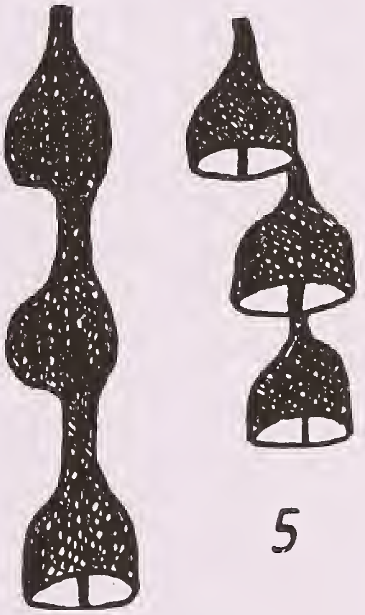
C. Mixed abnormal nests:

Such nests possess a combination of more than one kind of abnormality. Sometimes linear storeys as well as adjacent fusion may occur in the same nest complex. Combination of other abnormalities are also possible. This category of nests could be considered most complicated in terms abnormality (see Fig. 6).

Quantitative aspect of abnormal nests: A total 2996 nests were examined between 1982 and 1988 from four districts of Rajasthan state to study the trends of abnormalities. The findings are given in Table 1.

Discussion

It is clear from table 1 that there is a trend towards bistoreyed nests followed by fused nests in the state of Rajasthan. Why and how abnormal nests are prepared by the Baya Weaver Bird, is beyond the scope of this paper, however a few related points will be discussed .



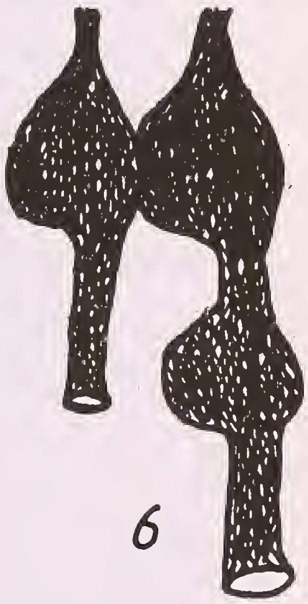


Fig. 5. Chain-storeyed nest.
Fig. 6. Mixed abnormal nest.

It is well known that armed host trees are preferred by the Baya for nesting, probably for

TABLE 1

ABNORMAL NESTS OF *PLOCEUS PHILIPPINUS*

Dist.	Year	Total number of nests observed	Simple Abnormal Nests																Mixed Abnormal Nests	Total no. of Abnormal nests
			Monostoreyed Nests													Pseudo-storeyed Nests	Bistoreyed Nests	Chain-storeyed Nests		
			Structural Abnormality								Orientational Abnormality									
			A	B	C	D	E	F*	G	H	I	J	K	L	M					
Alwar & Bharatpur	1982	1952	-	8	-	-	-	-	-	-	9	-	-	-	1	-	2	-	-	20
Alwar	1984	239	-	-	-	1	-	-	-	-	7	-	-	-	-	-	1	-	-	9
Udaipur	1987	226	6	-	1	-	-	-	-	1	1	2	-	1	-	2	5	-	-	19
Alwar	1987	123	-	-	1	-	3	2	-	-	1	2	-	-	-	1	6	-	2	18
Jaipur	1988	197	-	-	-	-	-	2	-	-	4	2	-	-	-	-	13	2	-	23
Alwar	1988	259	-	-	-	-	1	-	1	-	-	-	2	-	-	2	3	-	-	9
Total		2996	6	8	2	1	4	4	1	1	22	6	2	1	1	5	30	2	2	98

A. Bell Jar shaped; B. Buttressed; C. Blind; D. Closed; E. Stalkless; F. Multistalked; G. Chained; H. Meshed; I. Fused; J. Branched; K. Symmetrical; L. Stomach shaped; M. Completed nest with double opening.

* Multistalked nests seen on dicot trees are depicted here. Those seen on *Phoenix sylvestris* are not included.

safety. The nests are often tossed around by wind and get entangled by the spines at inconvenient angles. To overcome this problem buttressed or widestalked or multistalked or stalkless or even shortstalked nests may be fabricated. Such nests are least subjected to conditions like simple harmonic motion due to wind thrusts. Stomach shaped nests are equally good to avoid SHM due to their peculiar alignment.

Though bistoreyed nests are common in Rajasthan, field observations reveal that more than three storeyed nests are not present in the study area. Multi-storeyed nests were noticed by Davis (1985) and Ambedkar (1980) in those areas where comparatively long monsoon periods prevail. In Rajasthan, the monsoon period is very short (2 months). The period of two months is very short to fabricate 6 to 10 nests, hence extensive storeyfication cannot be expected. That is why 'long chains of nests' are very rare in Rajasthan.

'Intra bird nest' fusion was seen in all the cases; no 'inter bird nest' fusion was observed in any colony. It suggests that the Indian Baya Weaver Bird has only reached up to a 'colonial nesting' level and has not yet reached the 'social nesting' stage like the social weaver bird (*Philetairus socius*) of South Africa.

The viewing of a double opening completed nest was quite an exciting experience, a rather rare happening in the breeding biology of the Baya Weaver Bird. An additional opening perhaps may be of use during emergency for escaping from the nest. It may be a useful device to shorten the length of the entrance tube to facilitate a larger number of feeding trips to keep pace with requirement of food for rapidly growing chicks. Though such nests have some advantages, the disadvantages are that they are quite prone to attack by predators.

ACKNOWLEDGEMENTS

I express my sincere thanks to the late Dr. Salim Ali and Dr. Shiva Sharma, Botany Dept., University of Rajasthan, Jaipur, for their capable guidance and encouragement. I would like to express my sincere thanks to all those forest officials and villagers who had helped me in various ways during this study. I thank Dr. Prabhakar Joshi for going through the manuscripts.

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AGE DETERMINATION OF DOLPHINS ENTANGLED IN GILLNETS ALONG THE KERALA COAST[1]

R.S. LAL MOHAN[2]

(*With two plates*)

Key words: *Stenella longirostris*, *Sousa chinensis*, *Tursiops truncatus*, *Neophocaena phocaenoides*, *Delphinus delphis*, *Pseudorca crassidens*, age determination

Age of the dolphins *Delphinus delphis* Linnaeus, *Stenella longirostris* (Gray), *Sousa chinensis* (Osbeck), *Tursiops truncatus* (Montagu), *Neophocaena phocaenoides* (Cuvier) and *Pseudorca crassidens* (Owen) found along the Kerala coast are determined based on the growth layers in the teeth. The teeth samples were collected from dolphins landed as by-catch in the gillnets. The growth layers offer reliable information on the age of dolphins. This is the first attempt in India to study the age of dolphins based on the growth layers.

INTRODUCTION

Growth layers in the teeth of marine mammals were observed by Owen (1840-45) and Eschricht (1845). But utility of it for age determination was recognised much later (Scheffer 1950 and Laws 1952). However, these studies were followed by Nishiwaki and Yagi (1953), Nishiwaki *et al.* (1958), Omura *et al.* (1962) and others. Though the early studies were made on sperm whales, the investigations were extended to other larger and smaller cetaceans. These growth layers are found to be annual in periodicity in *Tursiops truncatus* and in other cetaceans where the teeth of known age animals were examined (Sergeant 1959). The teeth of common dolphins, *Delphinus delphis* and the *Tursiops truncatus* of Canadian coast were found to have similar growth layers as in other delphinids.

Various techniques were developed to study the growth layers in teeth of cetaceans, (Klevezal 1980). Recently Scheffer and Myrick (1980) and Donovan (1985) reviewed the age determination in toothed whales. Information on the age composition is essential for rational management. Formerly this information on cetaceans was obtained from biological characteristics such as body length, eye lens, width and degree of closure of cranial sutures and number of *corpora albicantia* in ovaries. But it is observed that growth layers found in the teeth are reliable. Though there are many studies on the age determination of marine mammals from other countries, no information is available from India.

MATERIALS AND METHODS

Dolphins that got entangled in the gillnets at Calicut coast were taken for studies. After determining the species identity of the dolphins the details such as sex, length and weight and other important morphometric characters were noted. The head was boiled and the skull was cleaned. The teeth were cleaned by using Hydrogen peroxide solution for about 30 minutes, and preserved in a 70% ethanol for further study. Teeth should not be stored dry as they develop cracks. The commonly occurring

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[1] Accepted March 1994.

[2] Research Centre of Central Marine Fisheries Research Institute, Calicut 673 005, Kerala.
Present address: Conservation of Nature Trust, B/24, Gandhinagar, Calicut 673 005.

species of dolphins *Stenella longirostris*, *Delphinus delphis*, *Tursiops truncatus*, *Sousa chinensis*, and *Pseudorca crassidens* were studied. Good and healthy teeth from the middle of upper and lower jaws were selected. Sections were made by grinding the teeth on a water proof No. 400 sand paper. The teeth were ground on both sides so as to get sections of 300 to 400 micron thick. While grinding, water was added to the grinding surface. After grinding to the required thickness the teeth were kept in 5% Formic acid for etching for 1 to 2 hours. After removing the teeth from the Formic acid, the sections were rinsed in water for about 2 hours and allowed to dry at the room temperature. The duration of etching depends on the thickness of the sections. When properly etched, the growth layers can be seen distinctly as valleys and ridges. The etched sections can be examined under microscope with the help of slanting reflected light. Growth layers can be seen more clearly if the surface of the teeth were rubbed with pencil. The growth layers can be studied in the stained sections of the teeth also. Here the sections are kept in Formic acid for about 6 to 8 hours and stained by Hematoxylin and destained by acid alcohol and cleared by xylol. The sections were mounted in DPX mounting media. But better results were obtained in the etched sections.

OBSERVATIONS

Delphinus delphis (Plate 1, Fig. 1) : The study material consist of 12 teeth and taken from female dolphins of length 1670 mm and 1700 mm. It was observed that there was one growth layer in a dolphin of length 1670 mm where as there were 4 growth layers in the specimen measuring 1700 mm. It may be observed that the length of maturity of the species was about 2000 mm.

Stenella longirostris (Plate 1, Fig. 2): Ten teeth from two dolphins of length 1560 mm (male) and 1630 mm (male) were studied. The teeth from the dolphin measuring 1560 mm were found to have 4 growth layers where as the dolphin of length 1630 mm had 7 growth layers. Dolphin of length 1560 mm was found to be immature and that of length 1630 mm was mature.

Tursiops truncatus (Plate 1, Fig. 3): One specimen (male) of length 2050 mm was studied. The teeth were found to have one growth layer. A specimen 1710 mm in length had sprouting teeth characterised by the absence of dentine. Mohan (1982) observed foetus in two specimens 2350 mm and 2390 mm of length.

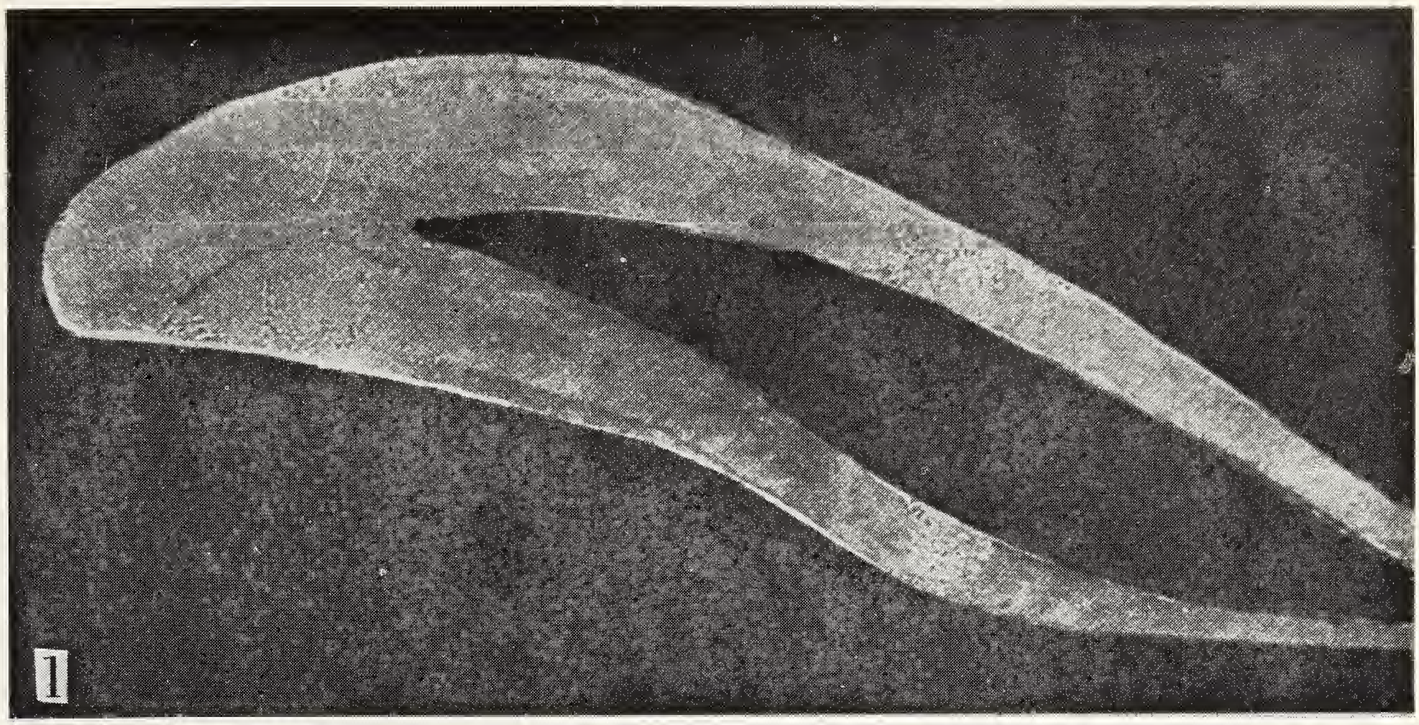
Sousa chinensis (Plate 2, Fig. 4): 12 teeth from 5 specimens ranging from 2020-3070 mm were studied. Teeth from the dolphin measuring 2020 mm had 4 growth layers and it was an immature female, with no *Corpora luteum* or *Corpora albicans* in the ovary. In the case of the dolphins measuring 2300 (male) and 2370 mm (male) 6 growth layers were observed in the teeth. In another specimen of length 2580 mm (female) the teeth had 8 growth layers. There were 11 growth layers in a specimen of length 3070 mm (male).

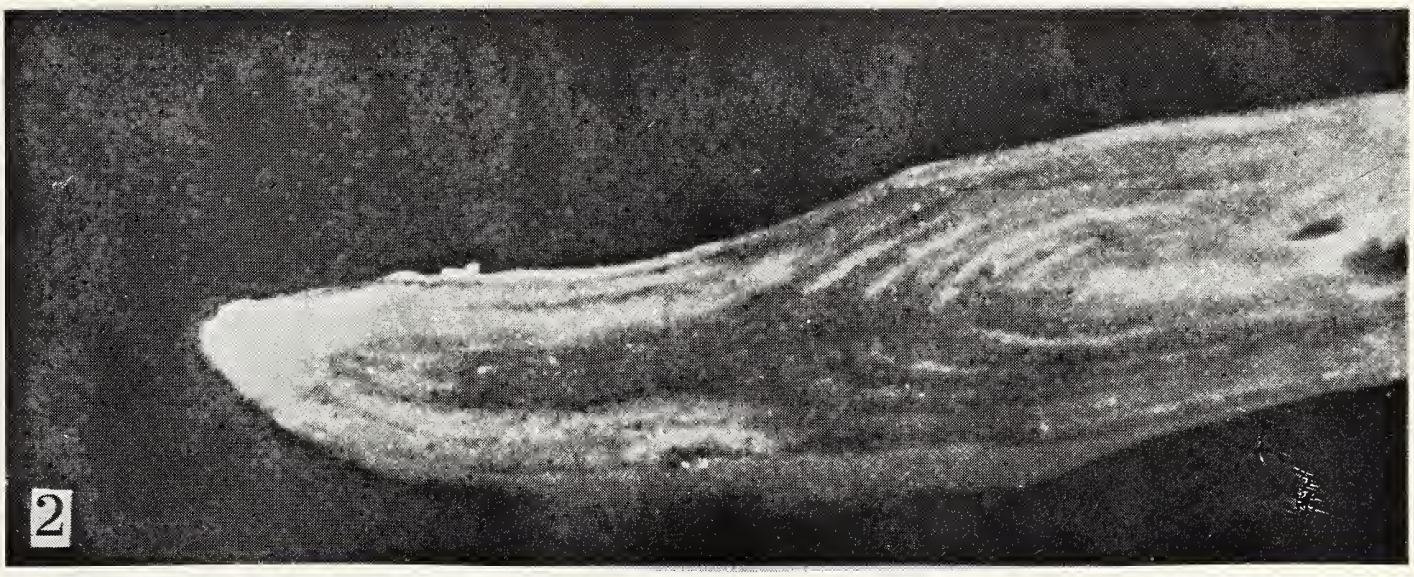
Neophocaena phocaenoides (Plate 2, Fig. 5): 3 teeth from a *Neophocaena phocaenoides* (male) of length 1350 mm were studied. There were 2 growth layers in the teeth.

Pseudorca crassidens (Plate 2, Fig. 6): A female *Pseudorca crassidens* of length 4230 mm had 14 growth layers.

DISCUSSION

The growth layers in teeth of *Delphinus delphis* of Indian coast are similar to that found in other areas. Kleinenberg and Klevezal (1962) examined the teeth of 33 dolphins from Black





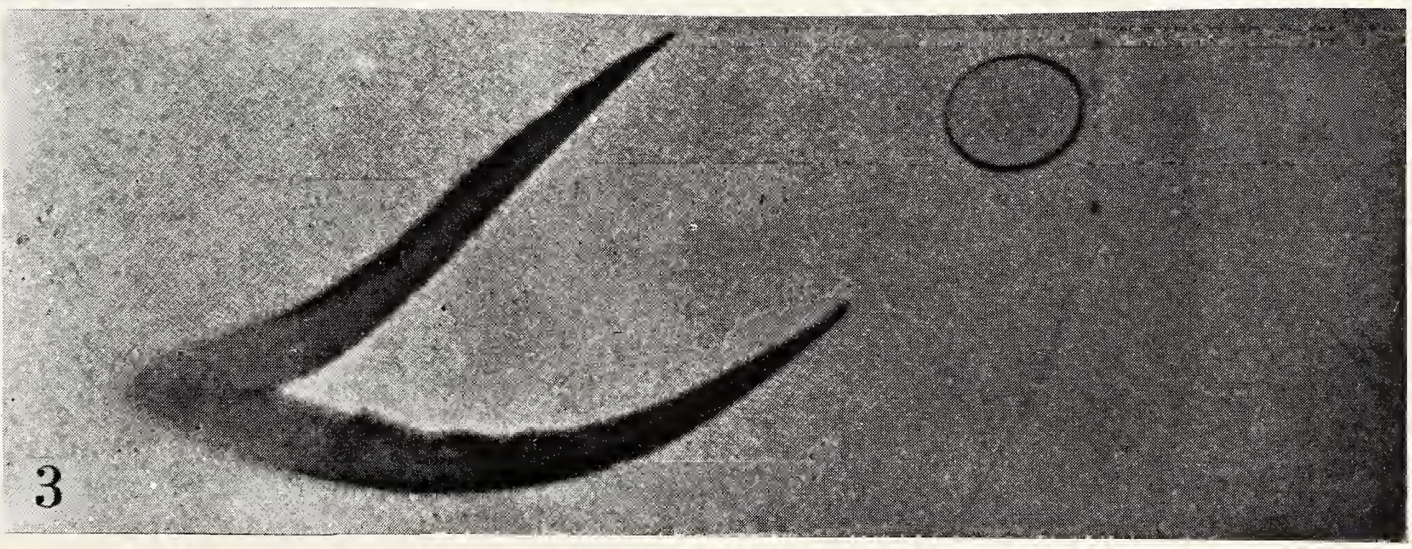
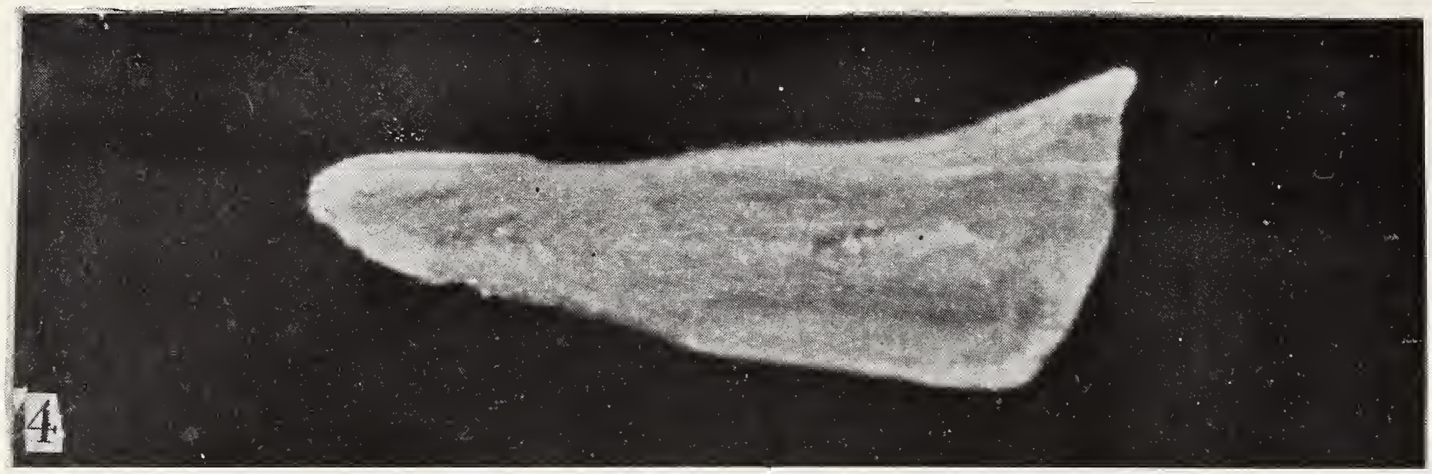
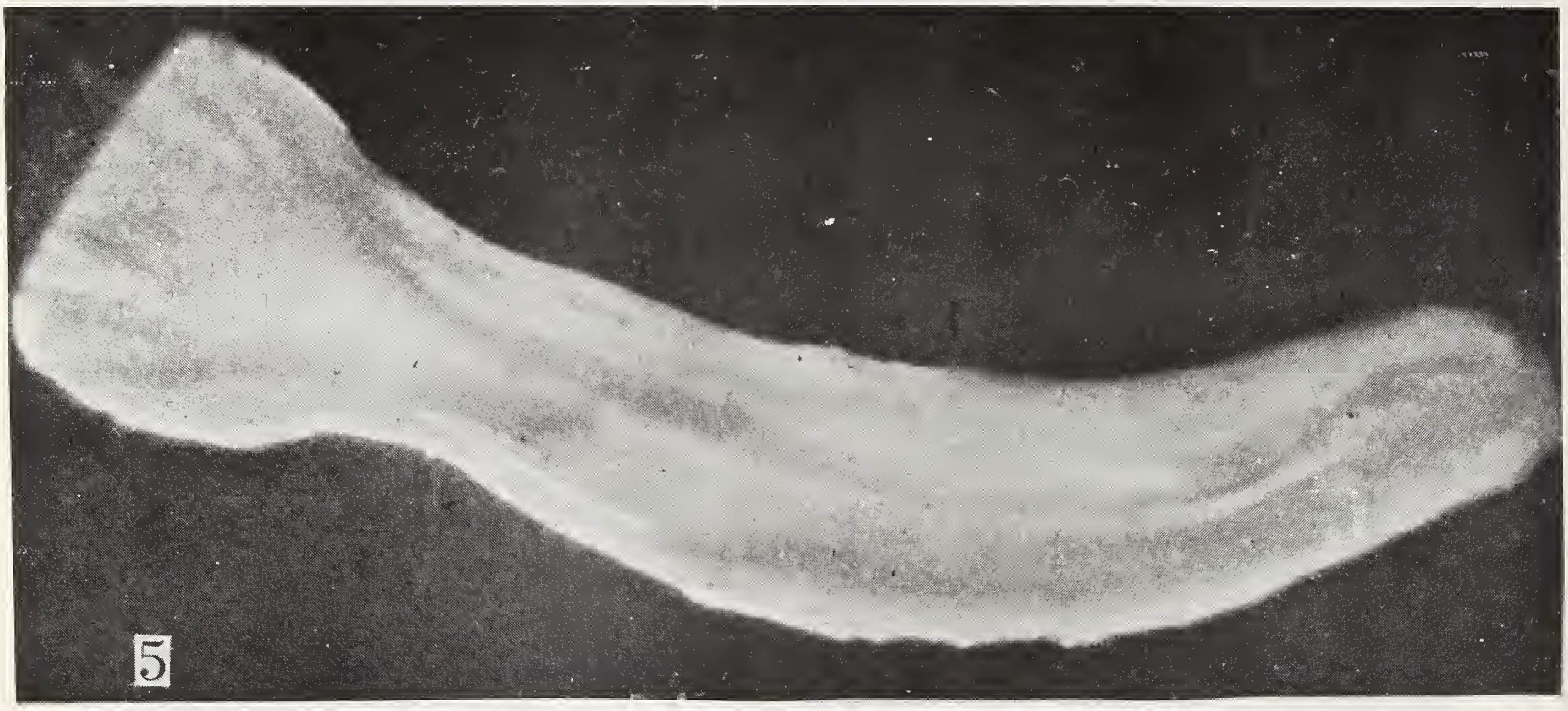


Fig. 1. Tooth section of *Delphinus delphis*; 1670 mm x 8; Fig. 2. Tooth section of *Stenella longirostris*; 1630 mm x 6; Fig. 3. Tooth section of *Tursiops truncatus*; 2050 mm x 6.





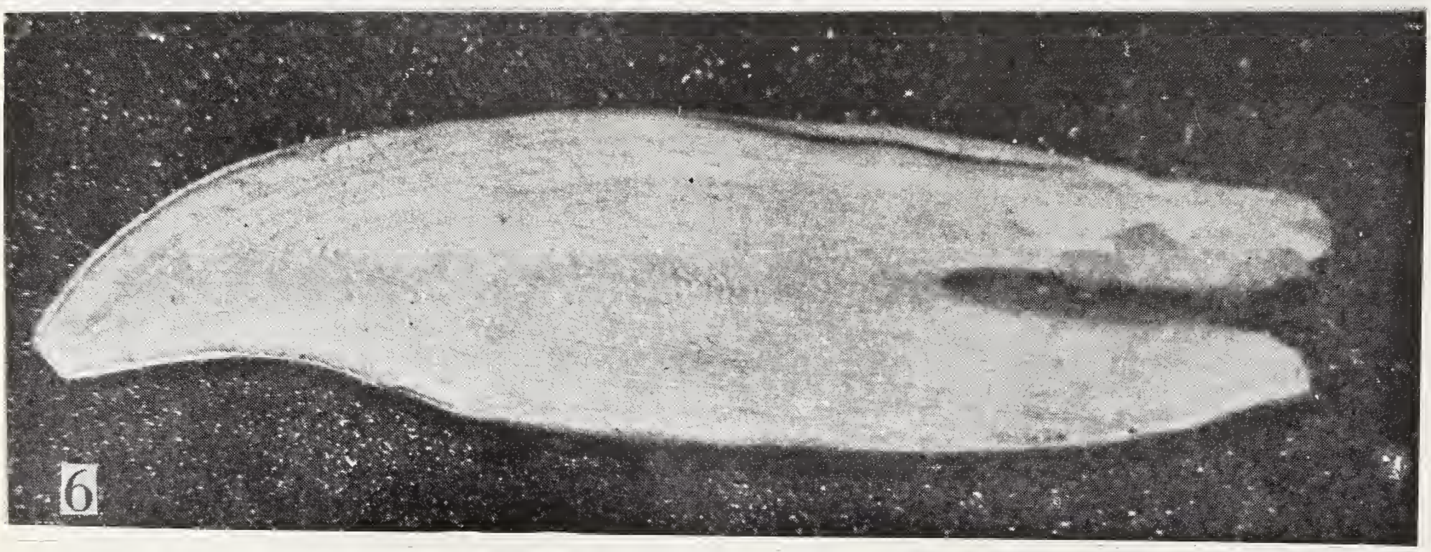


Fig. 4. Tooth section of *Sousa chinensis*; 2370 mm x 5; Fig. 5. Tooth section of *Neophocaena phocaenoides*; 1350 mm x 14; Fig. 6. Tooth section of *Pseudorca crassidens*; 4230 mm x 1.6.

sea and concluded that two light and two dark layers were laid down in each year. A specimen with 22 growth layers was considered to be 11 year old. Gurevich *et al.* (1980) also observed that two layers were formed annually in the species when the age was determined by Tetracycline markings. From the Indian coast one of the specimens measuring 1700 mm had 4 growth layers, and the specimen of length 1670 mm had only one layer. But as we do not have any data on the known-age, we cannot compare the growth layers.

Stenella longirostris (Spinner dolphin) is one of the well studied species. Perrin *et al.* (1977) observed that 1 or 1.5 growth layers were formed annually and that the length at maturity was 1700 mm at the age of 6 years with 6.4 growth layers in the teeth. It was further observed by Perrin and Henderson (1984) that the white bellied spinner dolphin of Pacific mature at about 6 years of age. The present observation also agrees with that of Perrin and Henderson (1984). The specimen of length 1560 mm having 4 growth layers had immature testis weighing 100 gm. It may be about 4 years of age. The specimen of length 1630 mm was probably about 7 years old. Its mature testis weighed 1250 gm.

Very little information is available on the age and other biological parameters of *Sousa chinensis* of India. The teeth of a dolphin of length 2370 mm had 6 growth layers whereas an immature specimen of length 2020 mm had 4 growth layers.

The age of *Tursiops truncatus* (bottlenose dolphin) was studied by Sergeant (1959). Klevezal and Kleinenberg (1967), Scheffer and Myrick Jr. (1980). They found that though in younger dolphins the growth layers were in close agreement with the age in years, in older animals there was no close relationship. However, the growth layers per year was observed in the teeth of known age animals and indicated that one growth layer was formed in a year. In the present observation also the teeth started sprouting in the specimen of length of 1710 mm and one growth layer was seen in a specimen measuring 2050 mm indicating that it was one year old. It should be maturing before 2390 mm as a 256 mm foetus was recovered from a dolphin of length 2390 mm (Mohan 1982). Kasuya *et al.* (1986) suggested, that 50% of female of the species matured at an age of 7 years in the Pacific Ocean. There is very little information available on the age of *Neophocaena phocaenoides*. Kasuya *et al.* (1986) estimated 80 cm as the neonatal length of the species and found that the growth layers were of annual periodicity. The mean body length at one year was considered to be 1200-1300 mm. The specimen examined from the Calicut coast measured 1380 mm and was found to have two growth layers. This observation agrees with that of Kasuya *et al.* (1986) and the specimen examined was 2 years old. The male *Pseudorca crassidens* of length 4230 mm may be 14 years old as its teeth section had 14 growth layers. Pierce and Kajimura (1980) found the growth layers in a *Pseudorca crassidens* and estimated its age to 14 years.

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NEW DESCRIPTIONS

TWO NEW SPECIES OF THE GENUS *APANTELES* FOERSTER (HYMENOPTERA: BRACONIDAE) FROM INDIA[1]

T.V. Sathe and D.M. Ingawale[2]

(*With two text-figures*)

Two new species, *Apanteles shrii* sp. nov. and *Apanteles endii* sp. nov., are described. The former is a parasitoid on *Erias vitella* (Stoll.) and the latter on *Achea janata* Linn.

Introduction

The genus *Apanteles* was erected by Foerster in 1862 and has since been studied by several authors (Marshall 1885, Muesebeck 1920, Wilkinson 1928a, b; Watanabe 1937, DeSaeger 1943, Nixon 1967). These workers did not consider the division of the genus into subgenera but Muesebeck (1920) synonymised 6 genera and one subgenus. Wilkinson (1932) divided the genus into five groups, namely M, A, F, U, and S. Nixon (1965) divided the genus into 42 species groups. Some of these groups are very large *ater, ultor,* etc. Rao (1961) divided the genus into two subgenera, i.e. *Areolatus* and *Carinatus* using propodial areola as a main, valid, and important character. But very recently, Mason (1981) kept *ater, taeniaticornis, mycetophilus, trifacsciatus, coesor* and *gradiculus* groups of Nixon under the genus *Apanteles*. He also included most of the species of *Metarpalis* group into *Apanteles*. Following the reclassification by Mason only 40% among the old *Apanteles* species remained under the genus while the rest were placed under different genera. Other workers on Indian species are Lal (1942), Bhatnagar (1948), Sathe and Inamdar (1988), Sumodan and Sevichan (1989), Sumodan and Narendran (1990).

The type materials are in the collection of T.V. Sathe, Dept. of Zoology, Shivaji University, Kolhapur and will be deposited in the collection of Zoological Survey of India, Calcutta.

Apanteles endii sp. nov.

(Fig. 1)

FEMALE: Length 1.80 mm without ovipositor, forewing 1.40 mm long, antenna 1.29 mm long.

Head (Fig. 1-a): In dorsal view, 0.26 mm long and 0.33 mm broad; interocellar space 0.09 mm long, eyes 0.10 mm broad and 0.14 mm long, interorbital space 0.08 mm long, frons shiny, ocelli in triangle. Antenna (Fig. 1-b) shorter than body, 16 segmented, 1.29 mm long, base of antenna 0.04 mm broad; clypeus 0.06 mm long, mandibles 0.04 mm long and 0.2 mm broad.

Flagellar formula: 2 L/W=2.50, 14 L/W = 2.50,
L 2/14=2.0, W =2/14 = 2.0.

Thorax: Thorax 0.92 mm long, mesoscutum punctate with few punctures, mesonotum rugose, metanotum with a pair of cetose lobe laterally; Precoxal suture present; Propodeum without areola, rugose, (Fig. 1-c) median carina short, transverse carinae not so prominent, lateral carinae joins with each other at anterior. Forewing (fig. 1-d) 1.40 mm long and 0.62 mm broad; costa 0.75 mm long and 0.12 mm broad, stigma 0.25 mm long; median cell 0.56 mm, basal 0.24 mm, discoideus 0.26 mm, transverse cubitus 0.12 mm and Ist abscissa of radius 0.15 mm, other cells not clearly observed. Hind wing: (Fig. 1-e) hind wing 1.20 mm long and 0.38 mm broad, subcostella 0.20 mm long and 0.15 mm broad. Hind leg (Fig. 1-f) 1.59 mm long; coxa 0.22 mm long and 0.14 mm broad, trochanter 0.15 mm long and 0.05 mm broad; femur 0.31 mm long and 0.07 mm broad, tibia 0.41 mm long and 0.06 mm broad, tibial spurs 0.08 mm long and 0.02 mm broad and equal; tarsus Ist 0.18 mm long, IInd 0.09 mm long, IIIrd 0.08 mm long, IV th 0.07 mm long, V th 0.05 mm long; claw 0.03 mm long, tibia and tarsus shiny; coxa, trochanter, femur brown; claw pointed.

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[1] Accepted January 1993.

[2] Department of Zoology, Shivaji University, Kolhapur 416 004. India.

Abdomen (Fig. 1-g): 0.62 mm long and 0.36 mm broad, ovipositor sheath 0.64 mm long and 0.04 mm broad; ovipositor 0.29 mm long, 0.03 mm broad, dark, broad at the base; sheath shiny, brown; Hypopygium without folds, 0.28 mm long, 0.35 mm broad; tergite I light brown, apically smooth, basally rugosopunctate, barrel shaped, II tergite rugosopunctate throughout; light brown; wider than long, 0.24 mm long, 0.35 mm broad. Ist & IIIrd tergites longer than IInd but equal in length.

Colour: Antenna, I and II tergite, light brown; mouth parts, segmental joints of antenna, leg except coxa, abdomen, ovipositor dark brown; head, abdomen black.

MALE: Similar to female.

Host: Lepidopterous larvae, *Achea janata.*

Holotype: FEMALE, M.S.; India, Medshingi, Tq. Sangola, polyphagus pests, coll. D.M. Ingawale from Aug. to Nov. 90; antenna, legs, wings on slide, labelled as above.

Paratype: 30 females and 12 males, sex-ratio, (m:f) 1:2.50. Coll. data same as of holotype.

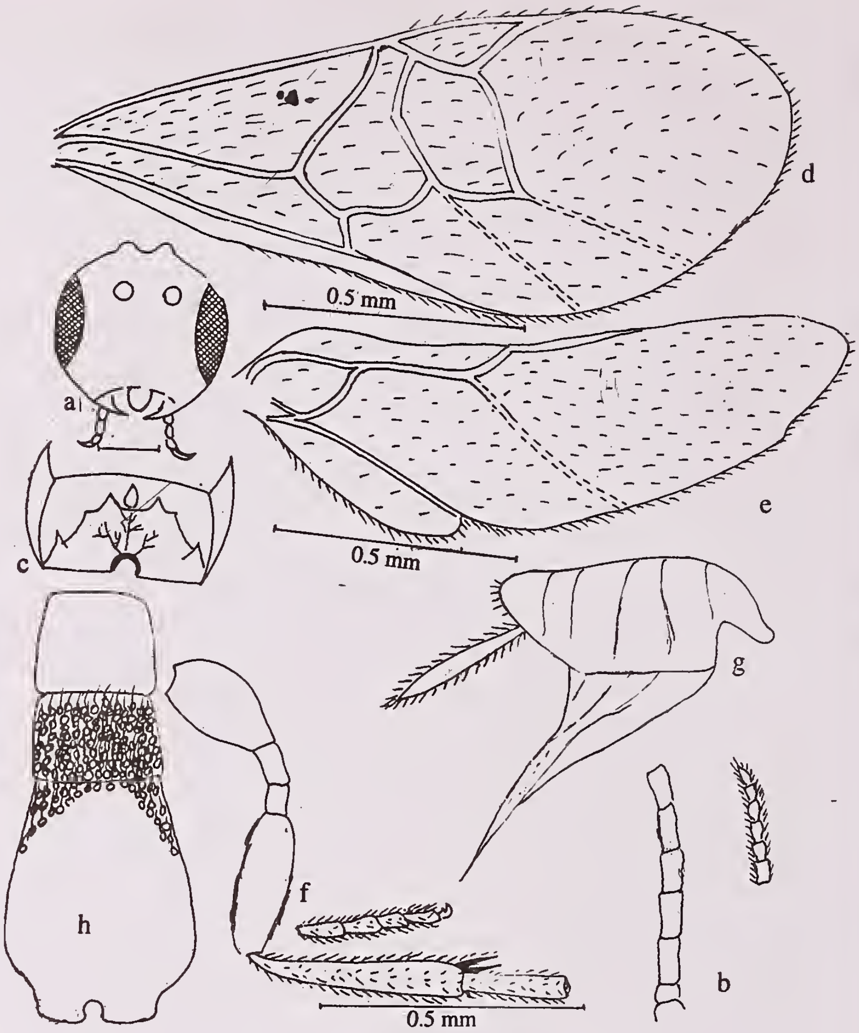

Fig. 1. *Apanteles endii* sp. nov.
a. Head; b. Antenna; c. Propodeum; d. Forewing; e. Hind wing; f. Hind leg; g. Abdomen; h. Tergite.

DISCUSSION

Apanteles endii sp. nov. resembles *Apanteles cama* in Nixon's (1965) key by the following characters:

1. Propodeum flat, 2. Hind leg longer than body and slender; 3. Vennal lobe hairy and convex.

The species also resembles *Apanteles cirphicola* Bhatnagar in Rao's (1961) key by the following characters:

1. Propodeum without areola and 2. tergite II not smooth.

However it differs from the above species in having:

1. ovipositor sheath longer than ovipositor; 2. tergite III longer than II; 3. antenna shorter than

body; 4. radius meeting to intercubitus at about 135°; 5. propodeum with short median carina, lateral carinae joined apically; 6. tibial spurs equal and 7. Flagellar formula:

2 L/W = 2.50, 14 L/W = 2.50
L 2/14 = 2.00, W 2/14 = 2.00

Apanteles shrii sp. nov.
(Fig. 2)

FEMALE: Female 2.57 mm excluding ovipositor, forewing 2.20 mm long, antenna 1.72 mm long and 16 segmented.

Head (Fig. 2-a): Head in dorsal view rectangular, dark brown; eyes 0.16 mm broad and 0.36 mm long; interocellar distance 0.15 mm and equal to interocellar space; ocelli in triangle; mandibles strong, pointed, basal width of mandible 0.03 mm and 0.07 mm long; malar space 0.08 mm; clypeus 0.12 mm long. Antenna (Fig. 2-b) 1.57 mm long with three ranks of placodes, 16 segmented.

Flagellar formula:
2 L/W = 2.25, 14 L/W = 1.666, L 2/14 = 2.0, W 2/14 = 1.33.

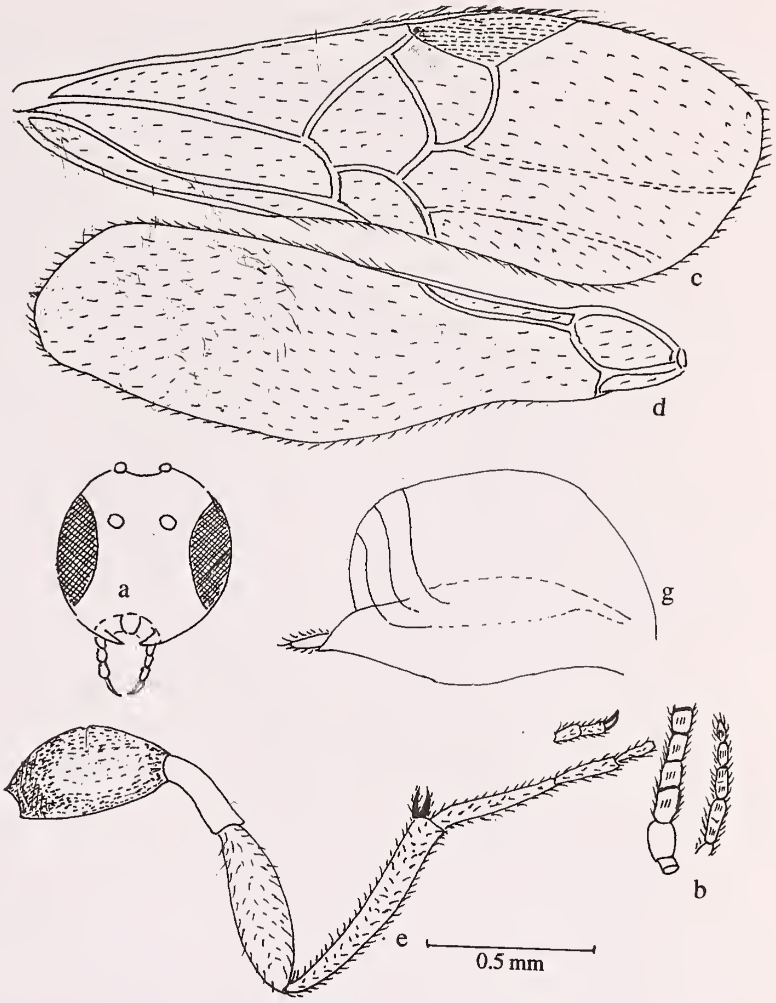

Fig. 2. *Apanteles shrii* sp. nov.
a. Head; b. Antenna; c. Forewing; d. Hindwing; e. Hind leg; g. Abdomen.

Thorax: 0.96 mm long, 89 mm broad; mesonotum deeply punctured posteriorly; metanotum with a pair of setiferous projections, cetose lobe sublaterally; propodeum with incomplete, deeply punctate with strong hairs & horizontal and transverse carinae, areola absent, anteriorly carinae some what 'U' shaped. Forewing (Fig. 2-c) 2.20 mm long, stigma 0.39 mm long, metacarpus 0.55 mm; discoidal cell area 0.29 mm, medius cell area 0.80 mm, subdiscoideus 0.45 mm long; II brachial, discoidal cell, III cubital cell area not clearly seen; median 0.78 mm long. Hind wing (Fig. 2-d) 1.80 mm long, costa 0.72 mm long and other area not clearly observed in it, vennal lobe hairy and convex. Hind leg (Fig. 2-e) 2.83 mm long, coxa 0.42 mm long and 0.24 mm broad, trochanter I and II 0.25 mm long and 0.7 mm broad, femur 0.50 mm long and 0.14 mm broad, tibia 0.71 mm long and 0.10 mm broad; tibial spurs equal, hairy, 0.07 mm long and 0.02 mm broad; tarsus 0.95 mm long and hairy; claw pointed, bended at the point.

Abdomen (Fig. 2-g): 0.95 mm broad and 0.65 mm long, light brown, petiole pointed; tergite I much longer than wide, rugose all over, strongly tapering apically, IInd tergite wider than long, sculptured, IIIrd tergite much longer than IInd; ovipositor 0.10 mm long and 0.04 mm broad, hairs absent, ovipositor shiny and yellow-brown.

Colour: Black, antenna; tibia, femur, abdomen brown; ovipositor, light brown.

MALE: Similar to female.

Host: Lepidopterous larvae, *Erias vitella* (Stoll.)

Cocoon: Faint yellow, cottony, 3.20 mm long.

Holotype: FEMALE, INDIA, Medshingi, Tq. Sangola, *Erias vitella* (Stoll.), coll. D.M. Ingawale from Aug. to Nov. 1990; antenna, legs, wings on slides labelled as above.

Paratype: 44 females and 20 males, sex ratio (m:f) 1:2.20, coll. data same as of holotype.

DISCUSSION

Apanteles shrii sp. nov. resembles *Apanteles sesamiae* Cameron in Rao's (1961) key by: 1. mesonotum punctured and 2. IInd tergite sculptured.

It also resembles *Apanteles numenes* in Nixon's (1967) key by having the: a. Ist tergite rugose and b. colour of antenna and ovipositor. However, it differs from the above species by:

1. propodeum with incomplete horizontal and transverse carinae, anterior carina 'U' shaped; 2. hind leg longer than antenna and tibial spurs equal; 3. antenna with three ranks of placodes; 4. tergite I rugose all over; 5. costa and stigma as long as broad; 6. Flagellar formula:

$$2\ L/W = 2.25,\ 14\ L/W = 1.66$$
$$L\ 2/14 = 2.00,\ W\ 2/14 = 1.33$$

ACKNOWLEDGEMENT

We thank the Shivaji University, Kolhapur for providing facilities.

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PARASITIC WASPS OF THE GENUS *DICLADOCERUS* (HYMENOPTERA: EULOPHIDAE) FROM NORTHERN INDIA[1]

M.A. KHAN[2]

(*With forty text-figures*)

Additional generic characters of pronotum, subgenital plate and external female genitalia are suggested for the genus *Dicladocerus* Westwood. The genus is reported for the first time from India. Four new species *D. indicus, D. antennalis, D.liriomyza* and *D. vigginaii* are described in detail. Key to the Indian species of the genus *Dicladocerus* is given.

INTRODUCTION

During a survey of insect pests of agricultural importance in northern India, I found four new species of (Eulophidae) parasitizing agromyzid species (Diptera).

These species are finely sculptured on the head and thorax, scutellum having a pair of longitudinal grooves. They belong to the genus *Dicladocerus* Westwood and constitute the first valid record of the genus in India.

Abbreviations: Funicular segments 1 to 3-F1, F2, F3, submarginal vein-smv; marginal vein-mv; stigmal vein-stv; cubital vein-cu, first valvifers-vf1; second valvifers-vf2; third valvulae-v3.

Genus *Dicladocerus* Westwood

Dicladocerus Westwood, 1832. Phil. Mag, (3) 1: 128. Type species: *Dicladocerus westwoodi*, by monotype.

Diagnosis: The generic diagnostic characters can be summed up as head transverse-subtriangular; eyes ovate and somewhat subprominent; gena about 1/2 to 1/3 length of eye; ocelli obtusely triangular; antennae inserted below, above or at ventral margin of eye; scape slender, reaching anterior ocellus; pronotum, mesoscutum and scutellum densely sculptured with latter having a pair of sublateral longitudinal grooves; median carina of propodeum generally weak and complete in female, plica usually weak and complete in female; wings hyaline; costal cell broad with a horizontal row of hairs on the lower surface extending from end to end, prestigma as long as stigmal vein and post marginal vein; abdomen elongately ovate to elongately lanceolate, apex acuminate; fore and middle coxae finely striate to strigose and hind coxae strongly sculptured.

In addition, some new generic characters are also suggested which will further facilitate the identification of this genus, namely posterior margin of pronotum without submarginal ridge with a small protuberance on each side, antero-lateral angle obtuse and laterally directed; subgenital plate broad, posterior margin with a notch in the middle; outer plate of ovipositor narrow at base, gradually widening posteriorly.

DISCUSSION

The genus *Dicladocerus* Westwood belongs to the subfamily Eulophinae (Eulophidae) and is distinguished from the related genera by the characters mentioned above. The genus fits very conveniently in the key Peck *et al.* (1964) and is apparently close to *Ratzeburgiola* Erdos. The

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[1] Accepted August 1994.

[2] Biological Control Laboratory, Department of Entomology, G.B. Pant University of Agriculture & Technology, Pantnagar 263 145, U.P.

structure of propodeum in the genus *Ratzeburgiola* with a median carina; sublateral plicae and transverse costula (as in *Pnigalio* Schrank, Boucek 1988, Fig. 1097); mesoscutum shining with numerous bristles; pmv at least twice as long as sv, female funicle always with four segments which separates the genus from *Dicladocerus*. Peck (1963) listed three species of *Dicladocerus* from North America. Boucek and Askew (1969) recognised four species of this genus from Europe. Boucek (1975) treated *Necremnus propodealis* Boucek as a synonym of *D. breviramulus* Boucek. Askew and Godfray (1987) confirmed the synonymy of *D. enryalus* (Haliday) and *D. aeneiscapus* (Thomson). Yoshimoto (1976) while making a revision of the genus has described twelve species from North America and one from Japan and has formulated its generic characters. Recently Hussain and Khan (1986) incorrectly declared *Solenotus guptai* (Subba Rao 1957) to be in *Dicladocerus* but it does not show any of the generic characters of the latter.

Biology: Primary parasitoids of Lepidoptera (Coleophoridae) and Diptera (Agromyzidae).

Distribution: Europe, England, North America, United States, Canada, British Columbia, Nearctic region, Asia, Central Japan, India.

In the present work four new species are described. A key to the Indian species is also proposed.

KEY TO THE INDIAN SPECIES OF THE GENUS *Dicladocerus* WESTWOOD BASED ON FEMALES

1. Frontovertex with reticulate sculpture; postocellar line almost or two times as long as ocellocular 2
   Frontovertex reticulate-punctate, big puncture clear; postocellar line one and one-half times as long as ocellocular; scrobes distinct and deep, convergent, interscrobal region rigid, surface of propodeum shagreened, smooth to alutaceous except sides of median carina micro-reticulate, median carina thin and moderately elevated anteriorly. *D. indicus* sp. nov.
2. Frontovertex one-half or less than one-half the total head width; pedicel less than two times as long as wide, distinctly shorter than F1. 3
   Frontovertex more than oen-half the total head width; pedicel long, less than three times as long as wide, distinctly longer than F1; F1 two times as long as wide' F2 a trifle longer than wide, F3 transverse, distinctly wider than long; club longer than preceding two funicle segments combined. . . . . *D. antennalis* sp. nov.
3. Antennae dark brown with two ring segments; prominence between antennal sockets less than one-fourth the width of frons between eyes; speculum narrow, pmv two times as long as stv, third valvulae four times as long as wide. . . *D. liriomyza* sp. nov.
   Antennae uniformly yellowish except F3 and club dark brown with only one ring segment, prominence between antennal sockets less than one-third the width of frons between eyes; speculum moderate, pmv longer than stv, third valvulae less than three times as long as wide. . . . . *D. viggianii* sp. nov.

Dicladocerus viggianii sp. nov.[3]

(Figs. 1-11)

FEMALE: Body length 1.29 mm. General body colour black, non-iridescent; head black, ocelli white, eyes silvery; antennae uniformly yellowish except F3 and club dark brown; thorax black except scutellum with a yellow patch in the middle; wings hyaline; legs white except fore coxa on greater part infuscated and middle femora with an opaque band in the middle; abdomen dark brown except basal one-third with a yellow patch.

Head: (Fig. 1) Much wider than long in facial view (0.54: 0.38); sparsely setose; frontovertex width less than one-half the total head width ((0.24: 0.54); ocelli arranged in obtuse triangle; postocellar line almost two times as long as ocellocular; eyes silvery; malar suture absent; malar space with three long setae on

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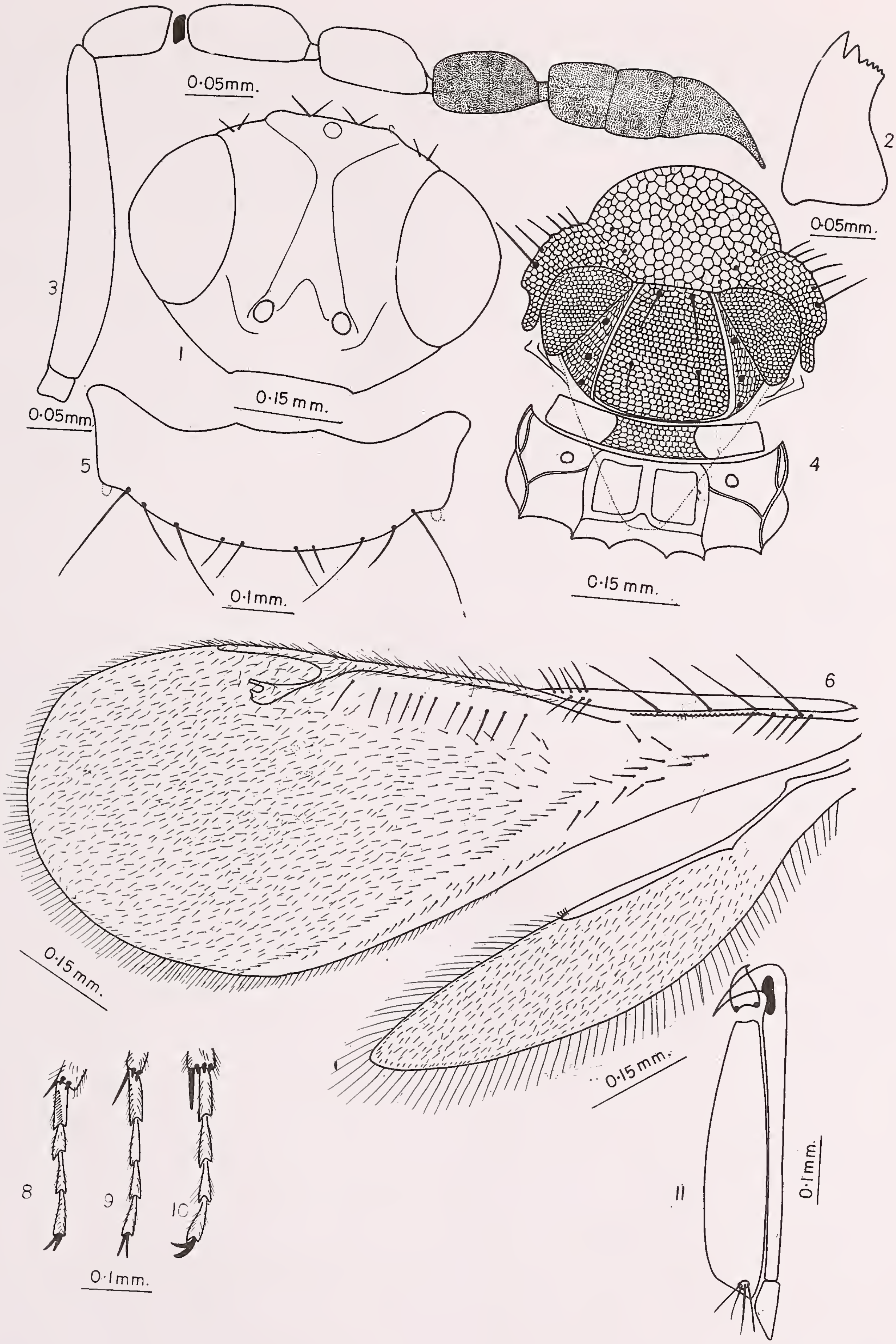
[3] This species is named for Dr. G. Viggiani in recognition of his valuable contribution to our knowledge of the Chalcidoidea.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Figs. 1-11. *Dicladocerus viggianii* sp. nov.
1. Head, in frontal aspect; 2. Mandible; 3. Antenna; 4. Thorax; 5. Pronotum; 6. Fore wing; 7. Hind wing; 8. Part of fore leg; 9. Part of middle leg; 10. Part of hind leg; 11. Ovipositor.

either side; slightly shorter than eye width (0.14: 0.15); antennae inserted at lower level of eyes; prominence between antennal sockets less than one-third the width of frons between eyes (0.09: 0.24); mandibles bidentate with acute teeth and serration (Fig.2), maxillary and labial palpi two and one segmented respectively.

Antennae (Fig. 3)**:** Eight segmented excluding one ring segment; scape cylindrical, almost seven times as long as wide (0.24: 0.035); pedicel less than two times as long as wide (0.06: 0.035), distinctly shorter than F1; funicle three segmented; F1 very long; two times as long as wide (0.09: 0.045), F2 less than two times as long as wide (0.08: 0.045); F3 as long as F2 but slightly wider, distinctly less than two times as long as wide (0.08: 0.05); club three segmented, more than three and a half times as long as wide (0.17: 0.05), longer than preceding two funicle segments together.

Thorax (Fig. 4)**:** Pronotum (Fig. 5) with posterior margin without submarginal ridge bearing six very long and twenty small sized bristles with a small protuberance on each side, antero-lateral angles obtuse and laterally directed; mesoscutum more than two times wider than long (0.4: 0.17), microreticulate; with three pairs of long setae; parapsidal grooves complete, faintly indicated; scutellum wider than long (0.28: 0.19), longer than mesoscutum, microreticulate; sublateral longitudinal grooves distinct; lateral area beyond scutellar grooves 2/3 micro-reticulate and 1/3 scalyreticulate; with three pairs of long setae; propodeum with median carina.

Fore wings (Fig. 6)**:** Less than three times as long as wide (1.27: 0.48); costal cell with five setae directed upward and three setae directed backward at apical end; basal vein with only three setae; basal cell bare; speculum moderate and closed below; cu sinuate; smv long (0.47) with four long setae directed upward and a row of five small setae directed backward; longer than mv (0.32); pmv (0.15) longer than stv (0.11); eleven admarginal hairs present; marginal fringe short.

Hind wings (Fig. 7)**:** Less than five times as long as wide (0.87: 0.17), with acute apex; marginal fringe moderate size.

Fore legs (Fig. 8)**:** Tarsal segments densely setose, tibial spur very short, apical rim of tibiae with two pegs.

Middle legs (Fig. 9)**:** Tarsal segments densely setose; tibial spur shorter than basitarsus, apical rim of tibiae with two pegs.

Hind legs (Fig. 10)**:** Tarsal segments densely setose; tibial spur shorter than basitarsus, apical rim of tibiae with three pegs.

Abdomen petiolate: Longer than head and thorax together; T1 well developed reaching beyond the middle of abdomen; ovipositor slightly exserted, arising from basal one-half of abdominal venter; Vf1 (Fig. 11) triangular with basal and apical angles at different level, v3 short (Fig. 11) less than three times as long as wide, less than one-sixth the length of vf2 (Fig. 11); outer plates of ovipositor distinctly shorter than vf3 (Fig. 11).

MALE: Not known.

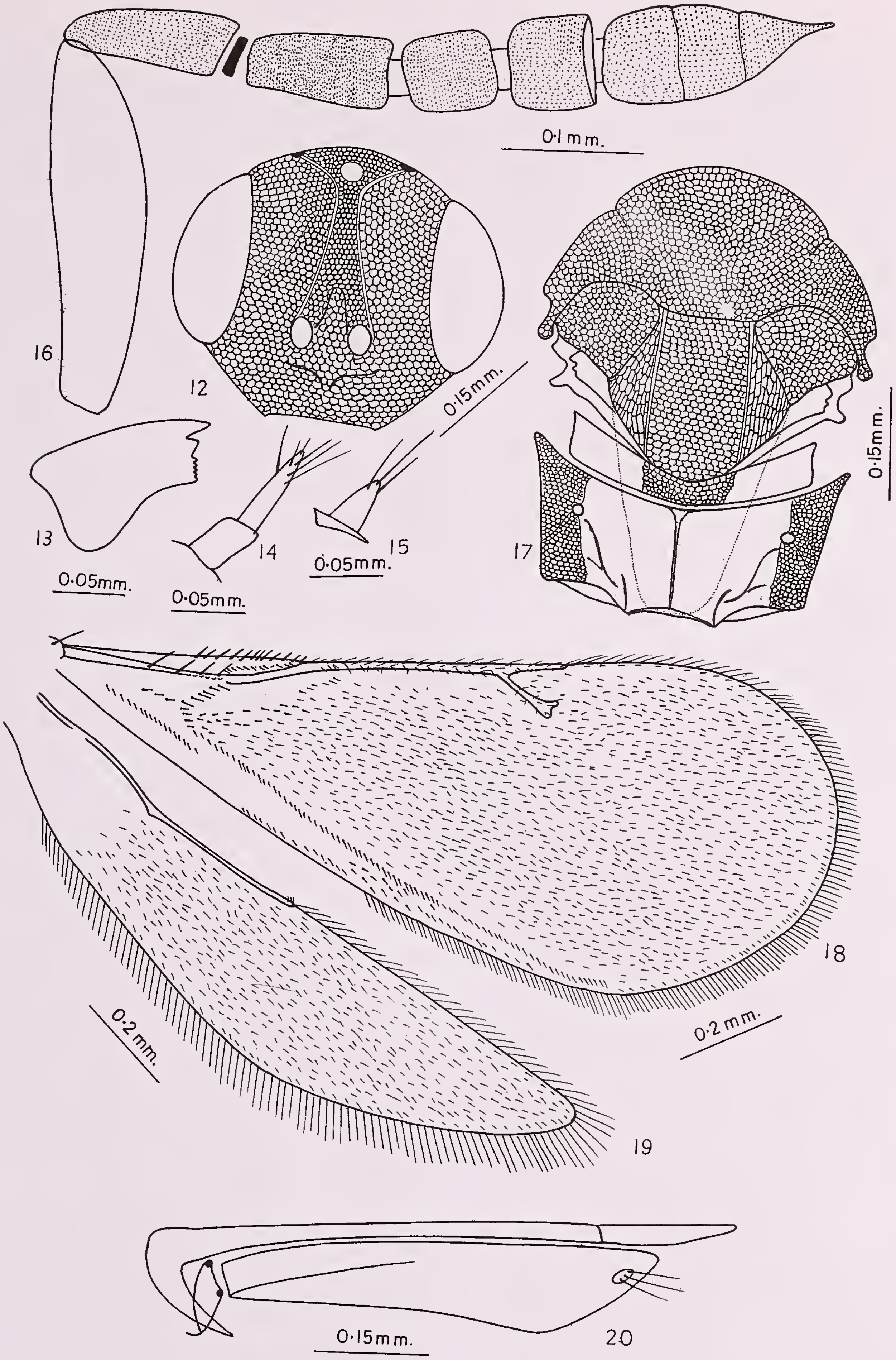
Holotype: ♀ INDIA, U.P., Bhimtal, ex. *Agromyza* sp. (Diptera: Agromyzidae) on *Trifolium alexandrium* Linn. (Leguminosae), 1-5-1986.

Paratype: 6 ♀♀ same data as holotype.

The holotype and 3 paratypes will be deposited in the Z.S.I. Calcutta, India; remaining paratypes are retained in the author's collection.

Dicladocerus antennalis sp. nov.
(Figs. 12-20)

FEMALE: Body length 1.31 mm. General body colour dark brown; antennae light brown except scape white; wings hyaline; legs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Figs. 12-20 *Dicladocerus antennalis* sp. nov. ♀
12. Head, in frontal aspect; 13. Mandible; 14. Maxillary palp; 15. Labial palp; 16. Antenna; 17. Thorax; 18. Fore wing; 19. Hind wing; 20. Ovipositor.

yellowish except fore coxa and femora light brownish, middle coxa at its basal end infuscated; abdomen dark brown except apical one-third yellowish.

Head (Fig. 12): With fine reticulate sculpture, wider than long in facial view (0.44: 0.38), frontovertex wider than long, width more than one-half the total head width (0.24: 0.44), ocelli dark, arranged in obtuse triangle, postocellar line two times as long as ocellocular; antennae inserted well above lower level of eyes; prominence between antennal sockets almost one-fifth the width of frons between eyes (0.05: 0.24); malar space longer than eye width (0.13: 0.01), malar suture absent, mandibles with acute teeth and serration (Fig. 13), maxillary (Fig. 14) and labial palpi (Fig. 15) two and one segmented respectively.

Antennae (Fig. 16): Eight segmented excluding one ring segment; scape cylindrical, less than four times as long as wide (0.26: 0.07), pedicel long, less than three times as long as wide (0.11: 0.04) distinctly longer than F1; F1 two times as long as wide (0.1: 0.05), F2 a trifle longer than wide (0.065: 0.06), F3 transverse, distinctly wider than long (0.7: 0.55), club three segmented, almost two and a half times as long as wide (0.17: 0.07), longer than preceding two funicle segments together.

Thorax (Fig. 17): Pronotum with fine reticulate sculpture, posterior margin with five pairs of setae; mesoscutum more than two times wider than long (0.44: 0.21), microreticulate sculpture; parapsidal furrows faintly indicated; scutellum slightly wider than long (0.24: 0.23) micro-reticulate, sublateral longitudinal grooves distinct, lateral area beyond scutellar grooves scaly reticulate; axillae finely and broadly reticulate; propodeum finely reticulate to alutaceous except along periphery of plica reticulate regulose, more than half the length of scuttelum, median carina thin, elevated towards anterior half, anterior part of plica thickened, moderately elevated on ridge, reaching spiracle at the distance of half its diameter; spiracles separated from the anterior margin of propodeum; mesopostphragma not reaching beyond propodeum.

Fore wings (Fig. 18): More than two times as long as wide (1.47: 0.61); broadly spatulate; costal cell with twelve setae on anterior margin of its apical half and twelve small setae directed backward in the middle; basal vein with six setae; basal cell setose; cu sinuate; speculum almost reduced and closed below; smv with four strong setae, longer (0.46) than mv (0.4); pmv (0.09) shorter than stv (0.1), marginal fringe short.

Hind wings (Fig. 19): More than four times as long as wide with acute apex; marginal fringe moderate size.

Legs: Fore and hind tibial spur short, middle tibial spur shorter than basitarsus; apical rim of middle and hind tibiae with two and one peg respectively.

Abdomen: shorter than head and thorax together; ovipositor slightly exserted; vf1 semicircular (Fig. 20); v3 (Fig. 20) long, seven times as long as wide, lanceolate, more than one-third the length of vf2, outer plates of ovipositor (Fig. 20) shorter than vf2.

MALE: not known.

Holotype: ♀ INDIA, U.P., Dehradun, ex. *Calycomyza humeralis* sp. (V. Roser) (Diptera: Agromyzidae) on *Blumea membranacea* DC. (Compositae), 20-4-1987 .

Paratype: 2 ♀♀ same data as holotype.

The holotype and 1 paratype will be deposited in the Z.S.I. Calcutta, India, remaining paratype is retained in the author's collection.

Dicladocerus indicus sp. nov.
(Figs. 21-29)

FEMALE: Body length 1.81 mm. General body colour dark brown with blue-green iridescence; antennae dark brown; wings hyaline; legs dark brown except middle legs with apical half of trochanter, apical tip of femora, basal one-fourth of tibia and basitarsus white.

Head: Reticulate sculpture with big punctures on frons, vertex; transverse subtriangular, distinctly wider than long in facial aspect; frontovertex wide, more than one-half the total head width (0.3: 0.58); scrobes distinct and deep, convergent, inter scrobal region rigid; postocellar line one and one-half times as long as ocellocular; antennae inserted at the level of ventral margin of eye, prominence between antennal sockets slightly more than one-third the width; eyes dark; mandibles (Fig. 21) with acute teeth and serrations; maxillary (Fig. 22) and labial palpi each one segmented (Fig. 23).

Antennae (Fig. 24)**:** Dark brown, eight segmented excluding two ring segments; scape cylindrical, more than five times as long as wide (0.29: 0.055); pedicel less than two times as long as wide (0.085: 0.05), more than half the length of F1; funicle three segmented, segments gradually decreasing in length distad but increasing in width; F1 more than two times as long as wide (0.14: 0.06); F2 less than two times as long as wide (0.115: 0.07); F3 shortest, longer than wide (0.11: 0.08); club three segmented, three times as long as wide (0.24: 0.08), longer than preceding two segments together.

Thorax (Fig. 25)**:** With fine reticulate sculpture; pronotum with anterior margin slightly concave, posterior margin slightly curved bearing three pairs of setae; mesoscutum less than two times wider than long (0.63: 0.33), coarsely reticulate; parapsidal furrows distinct anteriorly and faint posteriorly; scutellum wider than long (0.54: 0.33), micro reticulate, sublateral longitudinal grooves distinct, lateral area beyond scutellar grooves scaly reticulate; axillae finely reticulate; surface of propodeum shagreened, smooth to alutaceous except sides of median carina micro-reticulate, median carina thin and moderately elevated anteriorly, spiracles almost contiguous with anterior margin of propodeum.

Fore wings (Fig. 26)**:** Less than three times as long as wide (2.24: 0.86), broadly spatulate; costal cell short with three rows of hairs; basal vein with eight setae; basal cell with three setae; speculum narrowly longitudinal extending to base of mv, closed below; cu sinuate, partially closed, subcubital line of hairs broken for a short distance about one-third of distance from base; smv long (0.72) with eight long setae directed apically and a row of small eight setae at basal region directed backward, longer than mv (0.5), mv almost three times as long as stv, pmv (0.3) distinctly less than two times as long as stv (0.17); fifteen admarginal hairs present; marginal fringe short.

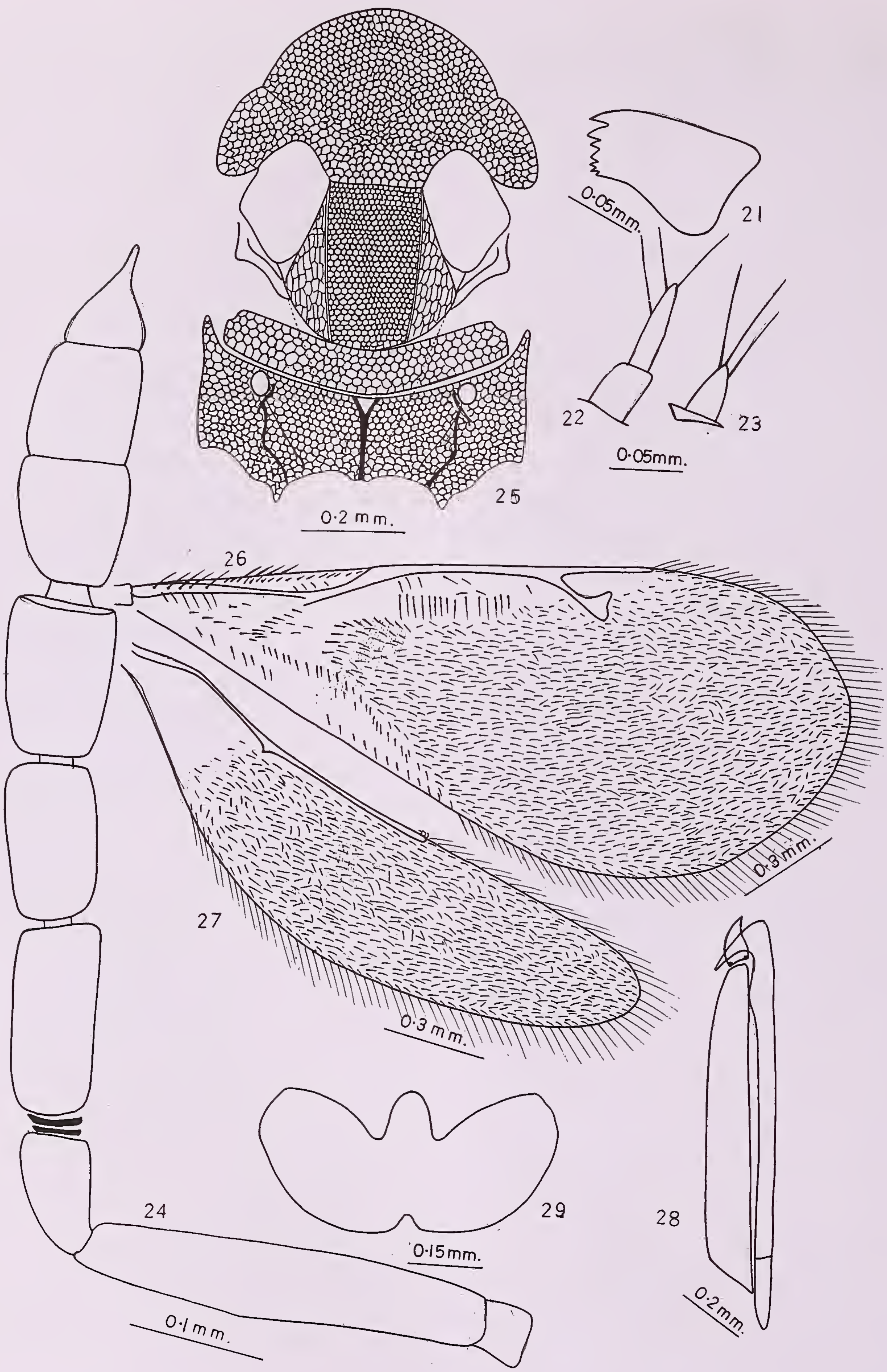
Hind wings (Fig. 27)**:** More than four times as long as wide (1.71: 0.41), broadly spatulate; marginal fringe long.

Legs: Tibial spur of fore and hind legs short, middle tibial spur shorter than basitarsus; apical rim of tibia and tarsal segments of all the legs densely setose.

Abdomen: Longer than head and thorax together; ovipositor exserted, arising from basal one-third of abdominal venter; vf1 (Fig. 28) triangular with articular knobs prominent, basal and apical angles at different levels; v3 short (Fig. 28) almost four times as long as wide, almost one-fifth the length of vf2 (Fig. 28); outer plates of ovipositor (Fig. 28) almost as long as vf2; subgenital plate broad, posterior margin with a notch in the middle (Fig. 29).

MALE: Not known.

Holotype: INDIA, U.P., Ramnagar ex. *Tropicomyia vigneae* (Seguy) (Diptera: Agromyzidae) on *Dolichos lablab* Linn.


0·05mm.
21
22
23
0·05mm.
25
0·2 mm.
26
0·3mm.
27
0·3mm.
24
29
0·15mm.
28
0·1mm.
0·2mm.

Figs. 21-29 *Dicladocerus indicus* sp. nov. ♀
21. Mandible; 22. Maxillary palp; 23. Labial palp; 24. Antenna; 25. Thorax; 26. Fore wing; 27. Hind wing; 28. Ovipositor; 29. Sub-genital plate.

(Leguminosae), 28-5-1986.

Paratype: 4 ♀♀ same data as holotype.

The holotype and 2 paratypes will be deposited in the Z.S.I. Calcutta, India; remaining paratypes are retained in the author's collection.

Dicladocerus liriomyza sp. nov.
(Figs. 30-40)

FEMALE: Body length 1.73 mm. General body colour dark bluish green with golden reflections; ocelli white, antennae dark brown; wings hyaline; fore legs uniformly dark brown except apical tip of femora and basal half of basitarsus white, middle and hind legs uniformly light brown except apical tip of femora, basal tip of tibiae and basitarsus white, tarsal segments 2-4 infuscated.

Head (Fig. 30): with fine reticulate sculpture; wider than long in facial aspect (0.64: 0.44); frontovertex width one-half the total head width (0.34: 0.68); scrobes deep and convergent above; ocelli arranged in obtuse angle triangle, postocellar line almost two times as long as ocellocular; antennae inserted just on the lower level of eyes; prominence between antennal sockets less than one-fourth the width of frons between eyes (0.09: 0.34); malar space shorter than eye width (0.14: 0.16); malar suture not distinct; eyes dark; mandibles with acute teeth and serrations (Fig. 31), maxillary (Fig. 32) and labial palpi (Fig. 33) two and one segmented respectively.

Antennae (Fig. 34): eight segmented excluding two ring segments; scape cylindrical, more than four times as long as wide (0.22: 0.04); pedicel less than two times as long as wide (0.08: 0.05), more than one half the length of F1; funicle three segmented, F1 segment more than two times as long as wide (0.13: 0.06), F2 less than two times as long as wide (0.11: 0.06), F3 as long as F2 but a trifle wider (0.11: 0.065); club three segmented, more than three times as long as wide (0.11: 0.07), longer than preceding two funicle segments together.

Thorax (Fig. 35): pronotum (Fig. 36) with posterior margin slightly curved, posterior submarginal ridge bearing three pairs of setae, its mid dorsal area coarsely reticulate, anterior two-third strigose; mesoscutum more tahn two times wider than long (0.61: 0.23), coarsely reticulate; scutellum somewhat flattened in the middle, less than two times wider than long (0.52: 0.33), micro-reticulate, sub-lateral longitudinal grooves distinct, lateral area beyond scutellar grooves scaly reticulate; axillae finely reticulate; median carina of propodeum weak and complete.

Fore wings (Fig. 37): more than two times as long as wide (1.8: 0.8) broadly spatulate; costal cell broad with two rows of hairs extending from end to end; basal cell bare; speculum narrow, closed below; cu sinuate; subcubital line of hairs long, starting from the base of cu; smv long (0.6) with twelve long setae, longer than mv (0.48); mv less than two times as long as stv; pmv (0.24) less than two times as long as stv (0.13), thirteen admarginal hairs present; marginal fringe short.

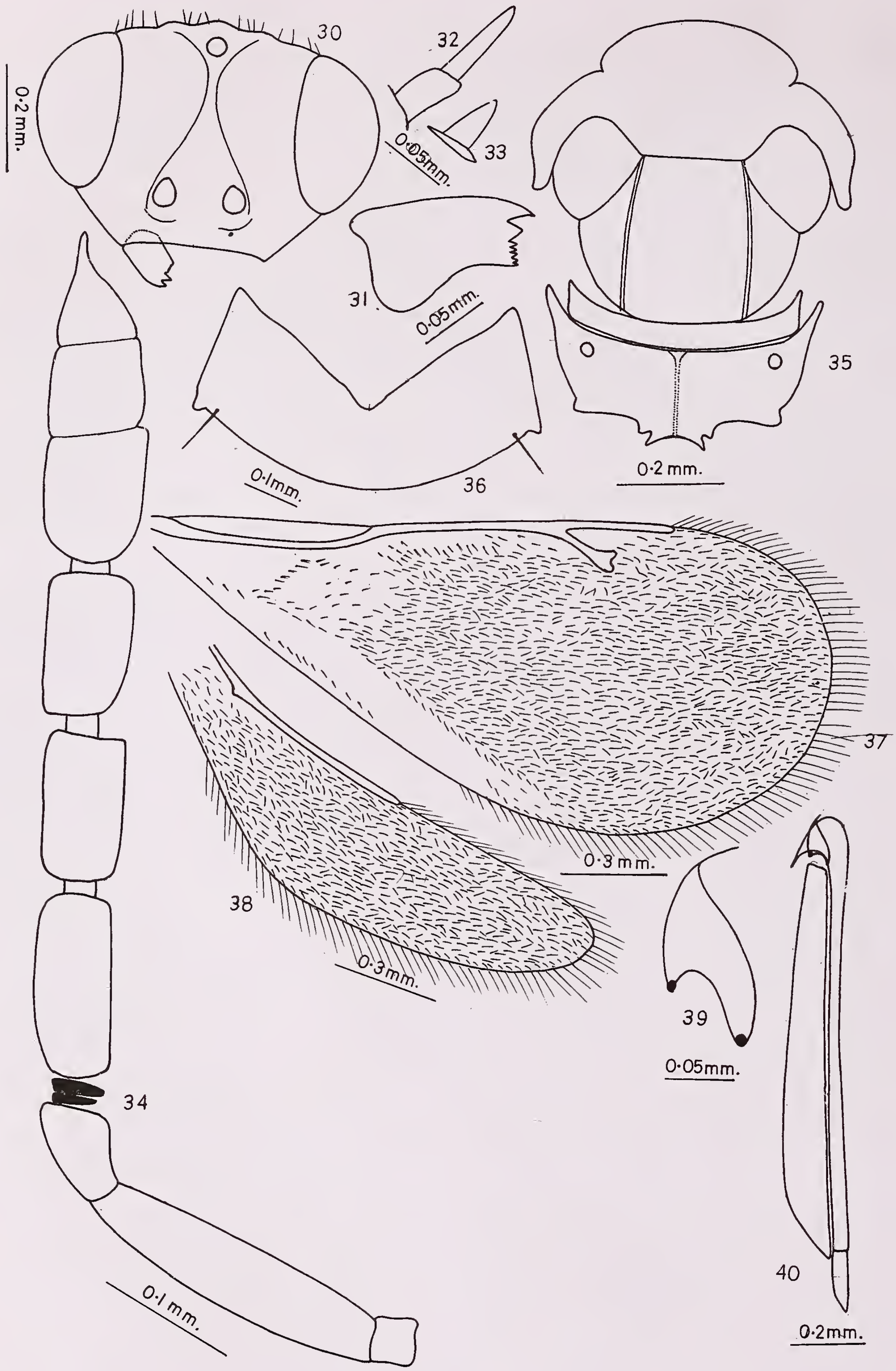
Hind wings (Fig. 38): less than four times as long as wide with blunt apex; marginal fringe moderate size.

Fore legs: tibial spur very short; coxa finely striate to strigose.

Middle legs: tibial spur short; coxa finely striate to strigose.

Hind legs: tibial spur shorter than basitarsus, densely setose; coxa coarsely reticulate sculptured.

Abdomen: longer than head and thorax together, ovipositor slightly exserted, arising from basal one-third of abdominal venter; vf1 (Fig. 39) triangular with basal and apical angles at different levels; v3 (Fig. 40) short, lanceolate,


30
0·2 mm.
32
33
0·05mm.
31
0·05mm.
35
0·2 mm.
36
0·1mm.
37
0·3 mm.
38
0·3mm.
39
0·05mm.
34
0·1 mm.
40
0·2mm.

Figs. 30-40 *Dicladocerus liriomyza* sp. nov. ♀
30. head. in the frontal aspect; 31. Mandible; 32. Maxillary palp; 33. Labial palp; 34. Antenna; 35. Thorax; 36. Pronotum; 37. Fore wing; 38. Hind wing; 39; First valvifer; 40; Ovipositor

almost four times as long as wide, one-seventh the length of vf2 (Fig. 40); outer plates of ovipositor (Fig. 40); distinctly shorter than vf2.

MALE: not known.

Holotype: ♀, INDIA, U.P., Kathgodam ex. *Liriomyza compositella* (Malloch) Spencer (Diptera: Agromyzidae) on *Xanthium strumarium* Linn. (Compositae), 27-8-1986.

Paratype: 4 ♀♀ same data as holotype.

The holotype and 2 paratypes will be deposited in the Z.S.I., Calcutta, India; remaining paratypes are retained in the author's collection.

ACKNOWLEDGEMENTS

I thank Dr. P.K. Pathak, Professor and Head, Dept. of Entomology, G.B. Pant Univ. of Agril. & Tech.' Pantnagar, India for providing necessary research facilities. I am most grateful to Dr. Gennaro Viggiani, Professor, Institute of Agricultural Entomology, University of Naples, Italy and Dr. M.M. Agrawal, Professor and Chairman, Department of Zoology, A.M.U. Aligarh for critical reading of the manuscript and helpful suggestions. My special thanks are also extended to Dr. V.K. Sehgal, Professor, Department of Entomology, G.B. Pant University of Agriculture & Technology, for identifying the host species. Financial assistance from Indian Council of Agricultural Research, New Delhi in the research project is gratefully acknowledged.

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* Original not seen.

A NEW GENUS OF PTEROMALIDAE (HYMENOPTERA: CHALCIDOIDEA) FROM COORG, KARNATAKA[1]

P.M. SURESHAN[2] AND T.C. NARENDRAN[3]

(*With seven text-figures*)

A new Pteromalid genus, namely *Neoepistenia* gen. nov. and a new species *N. coorgensis* sp. nov. of the subfamily Cleonyminae from Coorg (Karnataka) are described. The distinguishing features of the genus from related genera are commented on.

INTRODUCTION

In our studies on Indian Pteromalidae (Sureshan and Narendran 1990, in press; Narendran 1992, Narendran *et al.* 1992a, b) we came across an interesting Pteromalid wasp belonging to the subfamily Cleonyminae. This was collected from the wet evergreen forests of Nemanakolly (South Coorg). Our studies reveal that the specimen belongs to a genus which is new to science. It neither fits into any of the published genera of Pteromalidae nor to any of the keys published by Peck *et al.* (1964), Graham (1969), Farooqi and Subba Rao (1985), Dzhanokmen (1987), Boucek (1988) and Boucek and Rasplus (1991). Hence the genus and species are described hereunder.

Neoepistenia gen. nov.

Type species: *Neoepistenia coorgensis* sp. nov.

Body moderately large and stout (Fig. 1). Head (Figs. 1, 3, & 4) uniformly and moderately raised reticulate with silvery white pubescence; occiput immargined; temples moderately converging; malar grooves distinct; anterior margin of clypeus straight; scrobe deep with carinate outer margin and inter-antennal ridge. Antennae (Fig. 2) inserted slightly above lower margin of eyes; toruli wide apart; antennal formula 11083.

Thorax reticulate punctate with moderately dense pubescence. Pronotum (Fig. 3) large with a median keel. Mesoscutum with notauli complete. Propodeum (Fig. 6) medially raised with a short median carina anteriorly cleft to embrace a sub-triangular cup (which is subdivided). Prepectus and metanotum reticulate punctate. Forewing (Fig. 5) with mv slightly longer than pmv; stv 0.3x pmv. Hind tibia with two unequal spurs, with an outer row of scattered spines in addition to thick hairs.

Gaster (Figs. 1 & 7) elongate, acuminate, length 4.1x width in dorsal view, reticulate punctate on sides of T2-T5, anterior part of T3 dorsally and T4 and T5 completely; ovipositor sheaths and ovipositor strongly protruded out.

Remarks: *Neoepistenia* has a longer pronotum, propodeum with a short median carina anteriorly cleft to embrace a sub-triangular cup (which is subdivided), dorsally flattened gaster and hence resembles *Parepistenia* Dodd and also in general structure of the body. *Parepistenia* however differs from it in having triangular spines on the dorsal edge of fore tibia, gaster with lateral keels dorsally, epipygium short and ovipositor not produced.

Neoepistenia also resembles *Reikisura* Boucek in general appearance, structure of antenna, etc. but differs in the absence of occipital carina, scrobe not reaching ocellus, in having longer pronotum and propodeum and in

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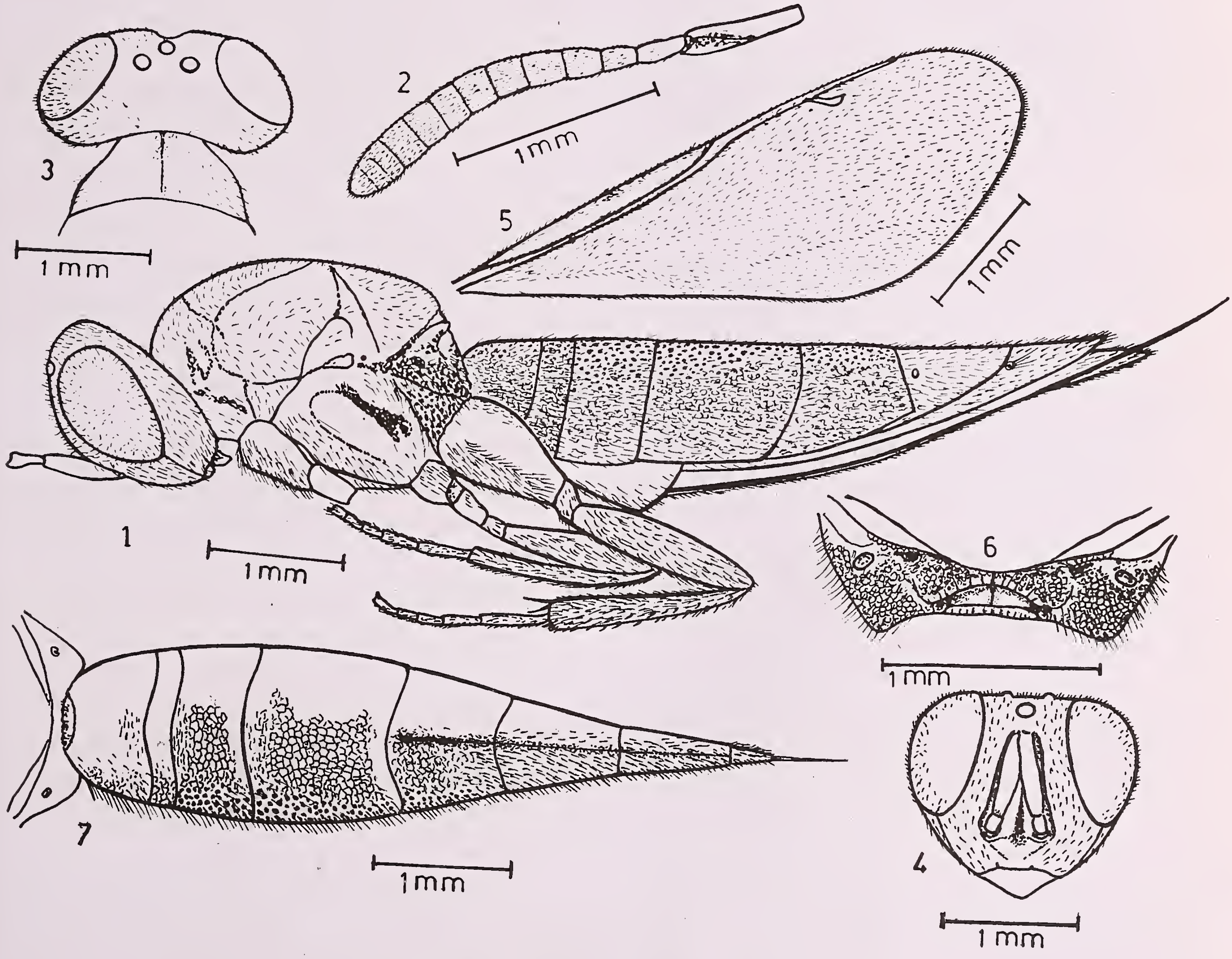
[1] Accepted August 1994.

[2] Zoological Survey of India, Western Ghat Field Research Station, Calicut, Kerala 673 002.

[3] Department of Zoology, University of Calicut,
Kerala 673 635.

the shape of gaster. In *Reikisura* occipital carina is conspicuous on sides, scrobe reaching ocellus, pronotum and propodeum very short and gaster highly conical at the tip.

Another genus to which *Neoepistenia* shows resemblance is *Thaumasura* Westwood in the shape of pronotum with a median keel and larger size of the body. *Thaumasura* however differs from it in having double infumation on the wings, longer eyes, swollen cheeks and gaster with an extended epipygium.



Figs. 1-7. *Neoepistenia coorgensis* sp. nov. : Female
1. Body in profile; 2. Antenna; 3. Head and pronotum in dorsal view; 4. Head in front view; 5. Forewing; 6. Propodeum; 7. Gaster in dorsal view.

Neoepistenia coorgensis sp. nov.
(Figs. 1-7)

FEMALE: Length 7.6 mm. Black with golden yellow reflection on mesoscutum and scutellum dorsally, metallic blue to violaceous reflections on propodeum and T1 and T4 of gaster dorsally; eyes dirty brown. Antennae black with slight metallic blue tinge on scape. Coxae concolorous with thorax; all femora dark brown; tibiae brown except base and tips testaceous; tarsi yellow with tips brown. Tegulae brown; wings hyaline; veins brown.

Head (Figs. 1, 3, 4) uniformly and moderately raised reticulate, reticulation engraved on vertex and occiput, with uniform silvery white pubescence. In dorsal view head width 2x length and in front view width 1.2x height; temples moderately converging, length 0.25x that of eye; POL 1.6x OOL; ocelli large; occipital carina absent; anterior margin of clypeus straight; malar grooves distinct; malar space length 0.4x that of eye; eye length 1.45x width in profile. Antennae (Fig. 2) inserted slightly above lower margin of eyes; toruli wide apart; scrobe deep with carinate outer margin and distinct interantennal ridge; scape not reaching median ocellus, length 0.6x that of the eye and 2.6x pedicel; pedicel plus flagellum length equal to head width; F1-F4 equal in length; F5 and F6 slightly shorter than F4 and equal in length; F7 and F8 slightly shorter than F6 and equal in length; club as long as two preceding segments combined; pubescence on antenna very small and dense.

Thorax (Figs. 1 & 3) reticulate punctate with moderately dense pubescence. Pronotum width 2.5x length with distinct median keel which is becoming faint at posterior end; collar not demarcated anteriorly. Mesoscutum width 1.4x length; notauli complete. Scutellum width almost equal to length. Propodeum (Fig. 6) width 2.3x of its maximum length, medially raised with a sharp transverse ridge, the area behind it lies in a vertical plane forming a sub-triangular cup which is subdivided medially, shiny anteriorly and with vertical rugae posteriorly; median carina short; plicae indicated only anteriorly; callus with dense pubescence; spiracles large and oval, area behind it raised reticulate. Mesepimeron reticulate punctate with a triangular shiny area beneath tegulae. Metanotum reticulate punctate. Forewing (Fig. 5) length 2.8x width, with brown pubescence; costal cell hairy only on upper half; basal cell hairy, distinct speculum absent; marginal fringe small. Relative lengths of smv, mv, pmv and stv as 26.5, 12, 10.5, and 3.5. Fore and hind coxae reticulate laterally; mid coxae shagreened; hind coxa length 1.7x width; hind femur length 0.9x that of hind tibia; hind tibia with two strong, unequal spurs, with an outer row of scattered spines in addition to the thick hairs.

Gaster (Figs. 1 & 7) elongate, acuminate, length 4.1x width in dorsal view and 1.7x that of head plus thorax combined; sides of T2-T5, anterior part of T3 dorsally and T4 and T5 completely reticulate punctate; engraved reticulate on sides of T1; pubescence dense on sides of T1-T5 and complete on remaining tergites; ovipositor sheaths and ovipositor strongly protruded out; hypopygium reaching beyond T3 up to one fourth length of T4.

MALE: Unknown.

Biology: Collected from wet evergreen forest over a dry wood heavily infested with wood boring beetles, probably a parasite of beetles.

Holotype: FEMALE: India: Karnataka: Nemanakolly (South Coorg), 7. iii. 1994, coll. P.M. Sureshan. The holotype is kept in the collections of Zoological Survey of India, Western Ghat Field Research Station, Calicut, but eventually will be deposited in the National Zoological collections of Zoological Survey of India, Calcutta.

Etymology: *Neoepistenia*, name from *Parepistenia*, owing to the close resemblance of this genus to *Parepistenia* Dodd. The species is named after the district of Karnataka state where it was collected.

ACKNOWLEDGEMENTS

One of us (PMS) is grateful to the Director, Zoological survey of India, Calcutta and the Officer in charge, Zoological Survey of India, Western Ghat Field Research Station, Calicut for providing facilities and encouragement. We are also thankful to the authorities of the University of Calicut, Kerala for the facilities provided.

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A NEW GENUS OF TINGINAE (HETEROPTERA) FROM SOUTHERN INDIA[1]

DAVID LIVINGSTONE AND S. JAYANTHIBAI[2]

(*With a text-figure*)

Longiscutella has been introduced as a new genus of the subfamily Tinginae. The monotypic species *Longiscutella menoni* resembles *Lasiacantha* Stål in its pronotal hood and paranotal expansion but differs from it by its much elongated proscutellum that reaches the posterior end of discoidal area and by the total absence of ciliation.

Longiscutella gen. nov.

In general appearance and development of pronotal hood and paranotal expansion this new genus resembles *Lasiacantha* Stål. But the extraordinary development of the areolated proscutellum, almost reaching the posterior end of the discoidal area of the hemelytra and the total absence of ciliation make it easy to recognise it from the latter. In all other recorded species of Tingidae, the proscutellum does not exceed the middle of the discoidal area.

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[1] Accepted September 1994.

[2] Department of Zoology, Madras Christian College, Tambaram, Madras 600 059.

Longiscutella menoni sp. nov.
(Fig. 1)

Moderately large; 3 mm long and 1.3 mm broad; testaceous; body bare; proscutellum acutely pointed, posteriorly reaching the posterior limit of the discoidal area; body beneath fuscus.

Head: Fuscus, armed with two loral, one frontal and two postgenal long tubercles, all reaching the base of the pedicel; antennae moderately elongate, pubescent; I & II segments slender; IV segment testaceous and pilose; proportionate lengths of antennomeres: 1:0.8:6.8:3; eyes reddish brown; antenniferous tubercles passing the scape; rostrum stramineous, rostral tip fuscus, passing mesosternum; rostral furrow broad, open, sternal laminae non areolate; bucculae biseriately areolate, fringed with short hairs, occluding the first rostral segment.

Thorax: Pronotum prominently convex; proscutum punctate, tricarinate, median carina anteriorly terminating as glabrous, broadly areolated hood, concealing the head and rising medially as high as the paranotal elevation, making a deep constriction at the base of the scutellum before merging with the latter posteriorly and continuing as its median carina up to its tip; laternal carinae posteriorly terminating on either side at the base of the proscutellum; paranotal expansion after having reflected over the proscutum reflects back over itself, making a deep dorso lateral groove; scutellum with 1-3 rows of areolae on either side of the median carina and acutely produced, almost reaching the posterior limit of the discoidal area; hemelytra not constricted, distally overlapping; subcostal area biseriately areolate, areolae hyaline, confluent with postcubital area; radial area biseriately areolate, confluent with the sutural area; discoidal area five to six areolae deep at the middle, tapering at both ends; sutural area with broad areolae; clavus prominently biseriately areolate; legs slender, femora slightly incrassated; tibia spiniform; tarsomeres testaceous, spiniform.

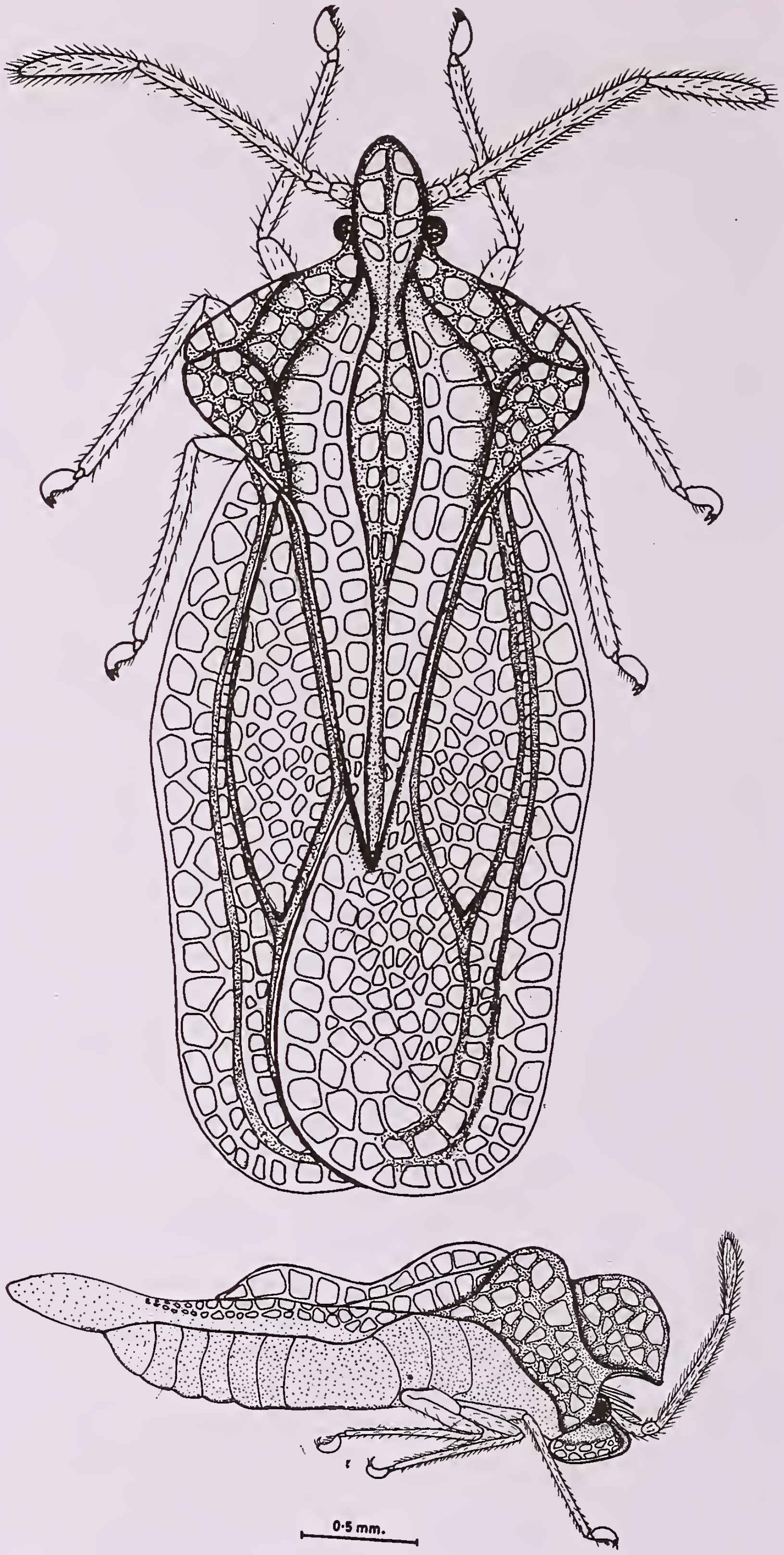

Fig. 1. *Longiscutella menoni* gen. et sp. nov.
Above: Dorsal view; Below: Lateral view.

Material examined: *Holotype:* Female, macropterous.

Locality: Vellainikara, Trichur, Kerala

(22.2.80).

Host plant: Triumfetta pilosa Roth - Tiliaceae.

Paratype: Two specimens, data same as holotype.

Type location: For the present in Livingstone's collection, Dept. of Zoology, Madras Christian College, Tambaram, Madras - 400 059.

ACKNOWLEDGEMENTS

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A REVISION OF GENUS *UNGULIA* MALAISE (HYMENOPTERA, SYMPHYTA, TENTHREDINIDAE: ALLANTINAE)[1]

MALKIAT S. SAINI AND V. VASU[2]

(*With forty four text-figures*)

With recognition of seven species (two already described and five new) genus *Ungulia* Malaise has been revised. Described as new are : *U. auratica, U. himalayaensis, U. brevis, U. scutopunctatus* and *U. acupunctata*. While *U. fasciativentris* Malaise represents first record from India. Treatment of each taxon includes synonymy (if any), detailed description, collection data, population variation (if any), and distribution. A key is provided for all species dealt herewith.

INTRODUCTION

Mainly based on the presence of a simple claw, absence of postgenal carina, malar space more than diameter of median ocellus, etc., the genus *Ungulia* was erected by Malaise in 1961, taking *Taxonus nigritarsis* Cameron, 1902 as its type species. So far, this genus was represented by two species only, i.e. *U. fasciativentris* Malaise and *U. nigritarsis* (Cameron).

In the present text, seven species are described and illustrated which include, two that have already been reported and five as new to science. Holotypes of new species are presently in our collections and will be deposited in the Indian Agricultural Research Institute (IARI), Pusa, National Collections, New Delhi, India after this work is published. Abbreviations used in the text are: EL- eye length, IATS- inner apical tibial spur, ICD- inter-cencheri distance, IDMO- interocular distance at level of median ocellus, ITD- inter-tegular distance, LID - lower inter-ocular distance, MB- metabasitarsus, OATS- outer apical tibial spur, OCL- ocello-occipital line, OOL- oculo-ocellar line, POL- postocellar line.

Genus *Ungulia* Malaise, 1961

Ungulia Malaise, 1961. Ent. Tidskr; Arg, 82, Hafte 3-4: 244-245.

Type species: *Taxonus nigritarsis* Cameron, 1902.

Diagnosis: Adult: forewing with 2 radial and 4 cubital cells; 2nd and 3rd of the latter subequal in length, and each receiving a recurrent vein. Basalis subparallel to medius and joins subcosta close to the base of cubitus. Nervulus at the apical 2/5 of the cell. Anal cell with a crossvein at apical fourth of the cell, nearly perpendicular with an angle of about 80°. Hindwings without closed middle cells, but the radiellan and anellan cell are closed, the latter with long petiole. Nervellus perpendicular only against the mediellan, but not against the brachiellan vein. Hindorbits not carinated. Inner margins of eyes subparallel. Head narrowing behind eyes; lateral furrows diverging posteriorly; postocellar area broader than long. Frontal area roundly elevated above a line touching both eyes, without carinae, and laterally unsharply limited by roundly depressed antennal furrows. Malar space as long as, or longer than pedicel. Clypeus subconvex, roundly emarginate. Mandibles subsymmetric, roundly curved, each with a subapical tooth near the apex. Antenna long; flagellum filiform. Mesopleura without presterna. Abdomen and legs normal; hind basitarsus subequal in length to following tarsal joints combined. Claws simple.

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[1] Accepted December 1994.

[2] Department of Zoology, Punjabi University,
Patiala 147 002, Punjab.

Remarks: To introduce some new species in genus *Ungulia*, some of its generic characters such as puncturation of head and thorax, specific ratio of postocellar area, specificity of post-, inter-, and circum- ocellar furrows, different conditions of scape and pedicel, specific colour pattern of the body, and ratio of antennal segments 3 and 4 have been intentionally dropped. All these characters should now onward be considered at species level only. This has been done with a view that we do not want to erect unnecessarily a new genus on the basis of these unstable and weak morphological characters.

KEYS TO SPECIES OF GENUS *Ungulia* MALAISE

1. Abdomen entirely black 3
* Abdomen not entirely black 2
2. Tergites 2-5 entirely auratus; postocellar area broader than long as 2:1; scape 1.3X its apical width; pedicel as long as its apical width . . . *U. auratica* sp. nov.
* Tergites 2-5 not entirely auratus; postocellar area broader than long as 3:1; scape as long as its apical width; pedicel 1.3X its apical width . . . . *U. fasciativentris* Malaise, 1961
3. Antennal segments 3 and 4 subequal; malar space less than 2X diameter of medial ocellus 4
* Antennal segments 3 and 4 equal; malar space 2X or more than diameter of median ocellus 5
4. Median fovea deep ditch-like in its anterior half and posteriorly not reaching median ocellus (Fig. 35); OOL:POL:OCL = 4:4:3; postocellar area broader than long as 3:2; segment 3 longer than 4 as 7:6; malar space twice as long as pedicel . . . . *U. acupunctata* sp. nov.
* Median fovea in the form of a shallow triangular pit in its anterior half and posteriorly only shallowly reaching median ocellus (Fig. 36); OOL:POL:OCL = 5:4:5; postocellar area broader than long as 4:3; segment 3 shorter than 4 as 6:7; malar space as long as pedicel . . . . *U. himalayaensis* sp. nov.
5. Postocellar area broader than long as 2:1; pedicel as long as 1/2 of its apical width; clypeus circularly emarginate up to 1/3 of its median length . . . . *U. brevis* sp. nov.
* Postocellar are broader than long as 3:2; pedicel as long as its apical width; clypeus only shallowly emarginate 6
6. Median fovea deep, ditch-like and clearly reaching median ocellus (Fig. 38); malar space 2.5X diameter of median ocellus and 1.5X pedicel length; OOL:POL:OCL = 4:4:5; . . . . *U. nigritarsis* (Cameron, 1902)
* Median fovea shallow, ditch-like in its anterior half and posteriorly only shallowly reaching median ocellus (Fig. 39); malar space 2X diameter of median ocellus and 1.2X pedicel length; OOL:POL:OCL = 4:4:3 . . . . *U. scutopunctatus* sp. nov.

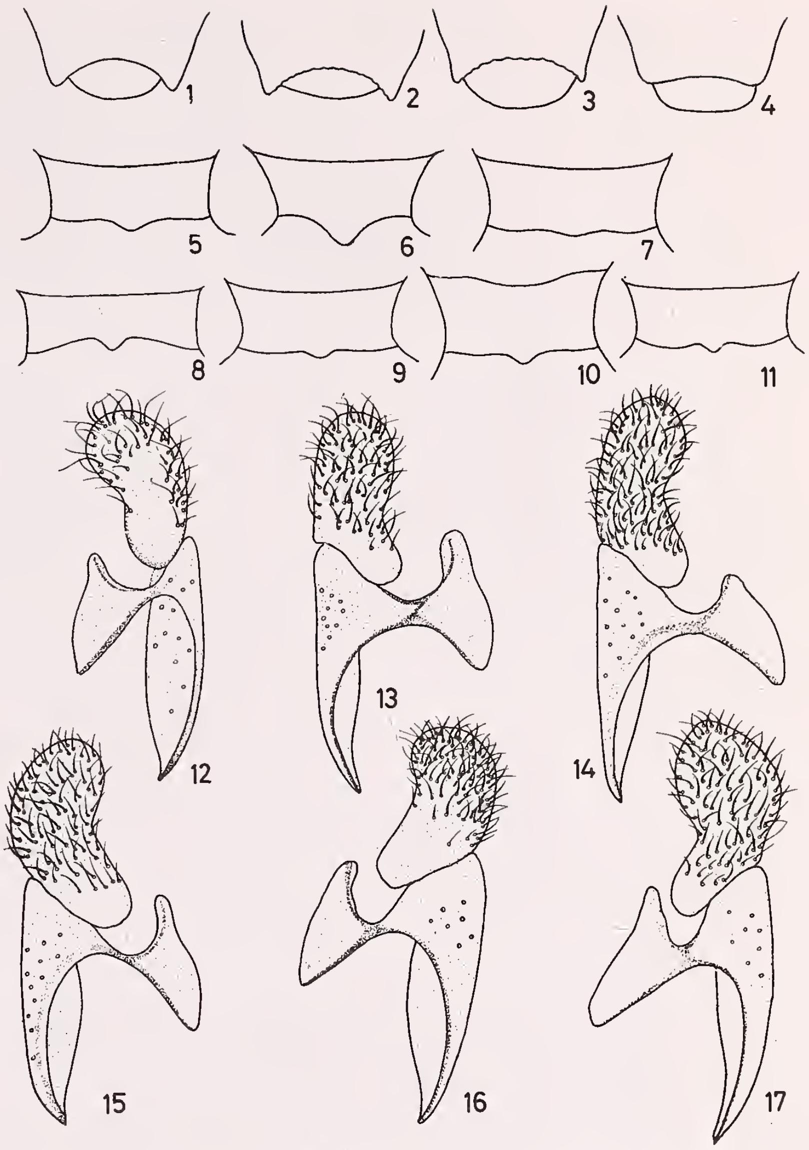
Ungulia auratica sp. nov.
(Figs. 1, 5, 17, 23, 26, 33, 40)

FEMALE: *Colour:* Body black, whitish yellow are: clypeus except extreme base; labrum; a transverse band on lower posterior half of mesepisternum; all legs except at joints of femora and tibiae, posterior aspects and apical 1/4 of all tibiae and all tarsi which are fuscus. Auratus are: tergites 2-6 entirely; all sternites entirely. Wings faintly infumated; venation including costa, subcosta and stigma piceous.

Structure: Average length 5 mm. Antenna (Fig. 40) 2.6X head width; scape 1.3X its apical width; pedicel as long as its apical width; segments 3 and 4 equal; clypeus (Fig. 1) circularly incised up to 1/3 of its medial length; labrum (Fig. 1) broader than long as 2:1, with deflexed rounded anterior margin; malar space 1.75X diameter of median ocellus and as long as pedicel; LID:IDMO:EL = 3:3:2; median fovea (Fig. 33) in form of a deep, circular pit in its anterior half and posteriorly only shallowly reaching median ocellus; post-, inter-, and circum-ocellar furrows sharp and distinct; lateral furrows deep, distinct, slightly diverging and ending abruptly well before the hypothetical hind margin of head; postocellar area subconvex, broader than long as 2:1; OOL:POL:OCL=2:2:1; mesoscutellum subconvex; appendage not carinated; ICD:ITD = 2:7; metabasitarsus subequal to following joints combined as 6:7; IATS:MB:OATS = 2:6:1.5. Lancet (Fig. 26) with 13 serrulae. Hypopygium as in Fig. 5.

Sculpture and pubescence: Head impunctate, shining; mesonotum with dense, minute, irregular punctures, surface shining; mesoscutellum with few shallow, scattered punctures on posterior border, surface polished; appendage impunctate, polished; mesepisternum and mesosternum impunctate, surface shining with oily lustre; abdomen impunctate shining. Body covered with silvery pubescence except for the auratus parts where it appears to be golden.

MALE: Average length 4.5 mm. Similar to female. Male genitalia: Penis valve (Fig. 23), gonoforceps (Fig. 17).



Figs. 1-4. Clypeus & Labrum: 1. *U. auratica* sp. nov.; 2. *U. fasciativentris* Malaise; 3. *U. nigritarsis* (Cameron); 4. *U. scutopunctatus* sp. nov.; 5-11. Hypopygium: 5. *U. auratica* sp. nov.; 6. *U. fasciativentris* Malaise; 7. *U. himalayaensis* sp. nov.; 8. *U. acupunctata* sp. nov.; 9. *U. scutopunctatus* sp. nov.; 10. *U. nigritarsis* (Cameron); 11. *U. brevis* sp. nov.; 12-17. Gonoforceps: 12. *U. fasciativentris* Malaise; 13. *U. himalayaensis* sp. nov.; 14. *U. nigritarsis* (Cameron); 15. *U. acupunctata* sp. nov.; 16. *U. brevis* sp. nov.; 17. *U. auratica* sp. nov.

Material examined: *Holotype:* FEMALE, Manipur, Ukhrul, 1700 m 22.9.1992. *Paratypes:* Nagaland, Kohima, 1495 m (4 ♀♀), 12.9.1992; Pfutsero, 2100 m (1 ♂), 19.5.1993. Arunachal Pradesh, Hapoli, 1500 m (2 ♀♀, 1 ♂), 17.5.1992. Manipur, Ukhrul, 1700 m (6 ♀♀, 2 ♂♂), 22.9.1992. Mizoram, Aizawl, 2100 m (1 ♀, 1 ♂), 14.5.1993; Lunglie, 1700 m (1 ♂), 17.5.1993.

Population variation: Tergite 2nd may be with somewhat fuscus anterior margin; tergite 6th may be fuscus partly; spot on lower posterior 1/2 of mesepisternum may be faintly indicated or absent.

Distribution: INDIA: Manipur, Nagaland, Arunachal Pradesh, Mizoram.

Diagnostic combinations: Though *U. auratica* comes close to *U. fasciativentris*, still some significant characters such as: tergites 2-5 entirely auratus (broad medial, auratus spot on tergites 2-5 in *U. fasciativentris*); postocellar area broader than long as 2:1 (3:1 in *U. fasciativentris*); scape 1.3X apical width (as long as its apical width in *U. fasciativentris*); pedicel as long as its apical width (1.3X its apical width in *U. fasciativentris*); median fovea in the form of a deep, circular pit in its anterior 1/2 and posteriorly only shallowly reaching median ocellus (median fovea in the form of a broad pit between antennae in *U. fasciativentris*); makes it distinct from *U. fasciativentris*.

Etymology: Species name pertains to general colour of its abdomen.

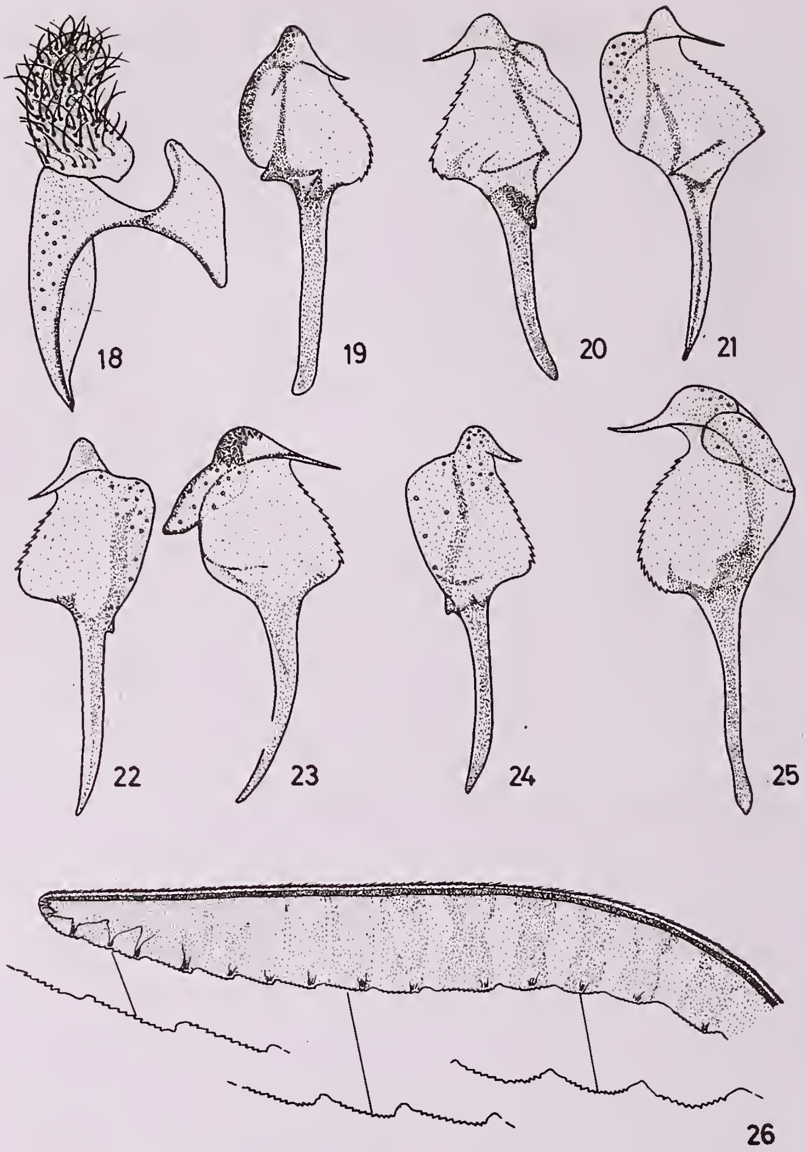
Ungulia fasciativentris Malaise, 1961

(Figs. 2, 6, 12, 24, 27, 34, 41)

U. fasciativentris Malaise, 1961. Ent. Tidskr; Arg, 82, Hafte 3-4, p.244.

FEMALE: *Colour:* Body black, yellowish white are: clypeus; labrum; a transverse spot along border of mesopleuron with mesosternum; all legs except extreme apex of all tibiae and tarsi entirely; all sternites and deflexed parts of all tergites. Auratus are: broad irregular medial spot on tergites 2-5. Wings infumated; venation including costa, subcosta and stigma dark brown.

Structure: Average length 6 mm. Antenna (Fig. 41) 2X head width; scape as long as its apical width; pedicel 1.3X its apical width; segments 3 and 4 subequal as 7:6; clypeus (Fig. 2) with wavy and faintly emarginate anterior margin; labrum broader than long as 2:1, with deflexed rounded anterior margin; LID:IDMO:EL = 3:3:2; malar space 1.5X diameter of median ocellus and as long as pedicel; frontal area elevated above level of eyes; median fovea (Fig. 34) in form of a broad pit between antennae; post-, inter-, and circum-ocellar furrows distinct; lateral furrows marked, diverging posteriorly and ending well before the hypothetical hind margin of head; postocellar area broader than long as 3:1; OOL:POL:OCL = 3:2:3; mesoscutellum flat; appendage not carinate; ICD:ITD = 1.0:3.5; metabasitarsus equal to following joints combined; IATS:MB:OATS = 1.5:4:1; Lancet (Fig. 27) having 14 serrulae. Hypopygium as in Fig. 6.



Figs. 18. Gonoforceps: 18. *U. scutopunctatus* sp. nov.; 19-25. Penis valve: 19. *U. himalayaensis* sp. nov.; 20. *U. nigritarsis* (Cameron); 21. *U. acupunctata* sp. nov.; 22. *U. brevis* sp. nov.; 23. *U. auratica* sp. nov.; 24. *U. fasciativentris* Malaise; 25. *U. scutopunctatus* sp. nov.; 26. Lancet: 26. *U. auratica* sp. nov.

Sculpture and pubescence: Head and thorax shining and minutely punctured; abdomen impunctate. Body covered with silvery pubescence except for auratus parts where it appears to be golden.

MALE: Average length 5.0 mm. Similar to female. Male genitalia: Penis valve (Fig. 24), gonoforceps (Fig. 12).

Holotype depository: FEMALE, NR Stockholm.

Paratypes depository: 2 ♀♀, 5 ♂♂, NR Stockholm.

Specimen examined: Arunachal Pradesh, Bomdila, 2550 m, (1 ♀, 8 ♂♂), 8.5.1992; (1 ♀, 14 ♂♂), 13.9.1992. West Bengal, Darjeeling, 2280 m, (6 ♂♂), 7.5.1993; Mirik, 1700 m, (4 ♂♂), 10.5.1993.

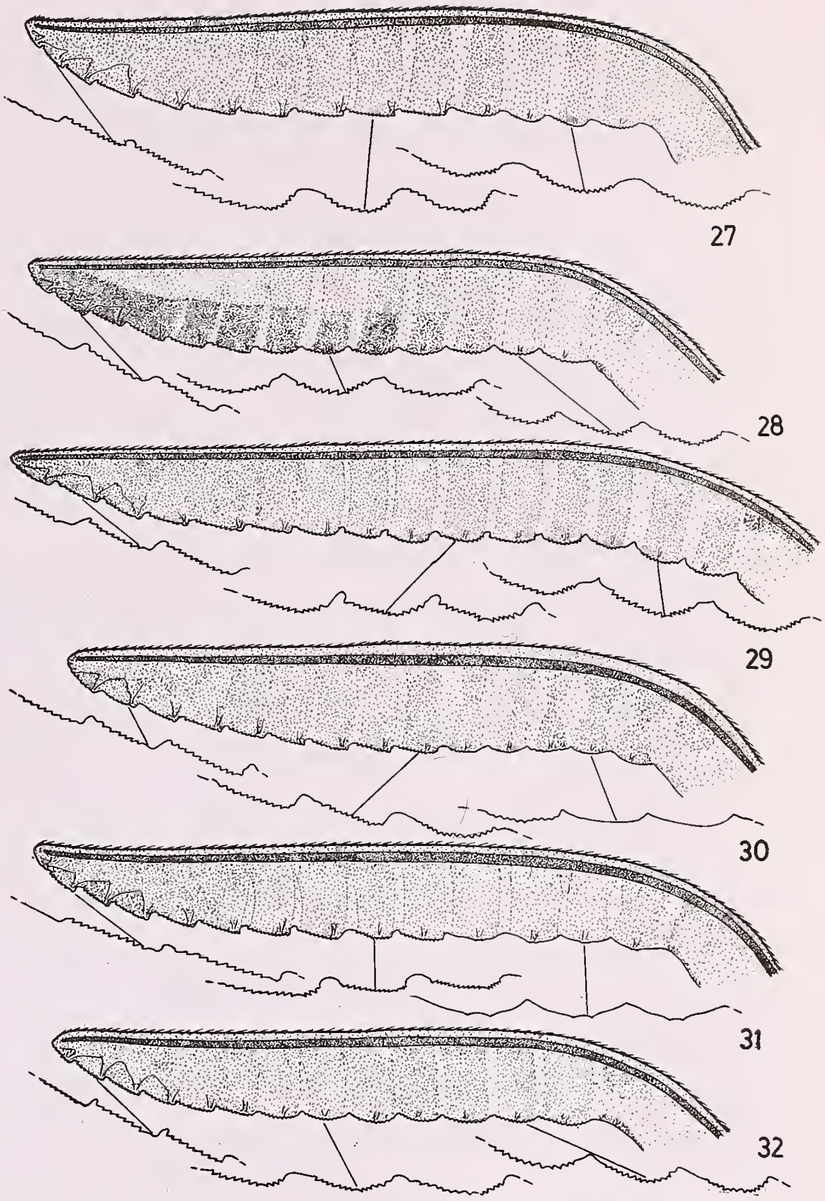
Population variation: An irregular medial spot may be present at least on any two adjoining tergites between 2-5.

Distribution: INDIA: Arunachal Pradesh, West Bengal.

Diagnostic combinations: *U. fasciativentris* Malaise remains distinct from all species dealt herewith in having tergites 2-5 with a broad medial auratus spot (entirely black in others except in *U. auratica* where these are entirely auratus); postocellar area broader than long as 3:1 (2:1 in *U. auratica* & *U. brevis*, 3:2 in *U. acupunctata*, *U. nigritarsis* & *U. scutopunctatus*, 4:3 in *U. himalayaensis*) and OOL:POL:OCL = 3:2:3 (2:2:1 in *U. auratica*, 4:4:3 in *U. acupunctata* & *U. scutopunctatus*, 5:4:5 in *U. himalayaensis*, 5:4:4 in *U. brevis*, 4:4:5 in *U. nigritarsis*).

Ungulia acupunctata sp. nov.
(Figs. 2, 8, 15, 21, 28, 35)

FEMALE: *Colour:* Body black, pale yellow are: clypeus; labrum; posterodorsal angle of pronotum; spot on mesopleuron; deflexed lateral sides of tergites 2-7; all legs except posterior stripe along pro- and meso-tibiae, all tarsi entirely which are brownish; underside of abdomen except dark brown apex. Wings infumated, venation including costa, subcosta and stigma black.



Figs. 27-32. Lancet: 27. *U. fasciativentris* Malaise; 28. *U. acupunctata* sp. nov.; 29. *U. himalayaensis* sp. nov.; 30. *U. brevis* sp. nov.; 31 *U. nigritarsis* (Cameron); 32. *U. scutopunctatus* sp. nov.

Structure: Average length 6 mm. Antenna (Fig. 41) 2X head width; scape as long as its apical width; pedicel as long as 1.3X its apical width; segments 3 and 4 subequal as 7:6; clypeus (Fig. 2) with slightly emarginate, wavy anterior margin; labrum broader than long as 2:1, with deflexed rounded anterior margin; malar space 1.75X diameter of median ocellus and 2X pedicel length; LID:IDMO:EL =

2.0:2.0:1.5; frontal area elevated above level of eyes; median fovea (Fig. 35) deep, ditch-like in its anterior half and posteriorly not reaching median ocellus; post-, inter- and circum-ocellar furrows deep, well marked; lateral furrows deep, diverging posteriorly and ending abruptly well before hypothetical hind margin of head; postocellar area broader than long as 3:2; OOL:POL:OCL = 4:4:3; mesoscutellum slightly elevated in middle; appendage not carinate; ICD:ITD = 2:7; metabasitarsus shorter than the following joints combined as 6:7; IATS:MB:OATS= 2.0:5.0:1.75. Lancet (Fig. 28) having 13 serrulae. Hypopygium as in Fig. 8.

Sculpture and pubescence: Head and thorax shining and minutely punctured; abdomen impunctate, surface subshining. Body covered with silvery pubescence.

MALE: Average length 5 mm. Similar to female. Male genitalia: Penis valve (Fig. 21), gonoforceps (Fig. 15).

Material examined: *Holotype:* Female, Arunachal Pradesh: Bomdila, 2550 m, 9.5.1992. *Paratypes:* Arunachal Pradesh, Bomdila, 2550 m, (30 ♀♀, 7 ♂♂), 8.5. 1992 - 9.5.1992; (20 ♀♀, 3 ♂♂), 13.9.1992; Dirang, 1500 m, (20 ♀♀, 2♂♂), 15.9.1992.

Population variations: Not observed.

Distribution: INDIA: Arunachal Pradesh.

Diagnostic combinations: Though the broad key characters such as abdomen entirely black; antennal segments 3 and 4 subequal; malar space twice the diameter of median ocellus bring *U. acupunctata* close to *U. himalayaensis*, it differs in the following characters: median fovea deep ditch-like in its anterior 1/2 and posteriorly not reaching median ocellus (shallow triangular pit in its anterior 1/2 and posteriorly shallowly reaching median ocellus in *U. himalayaensis*), postocellar area broader than long as 3:2 (4:3 in *U. himalayaensis*), segments 3 and 4 as 7:6 (6:7 in *U. himalayaensis*), malar space 2X pedicel (1X in *U. himalayaensis*) and OOL:POL:OCL = 4:4:3 (5:4:5 in *U. himalayaensis*).

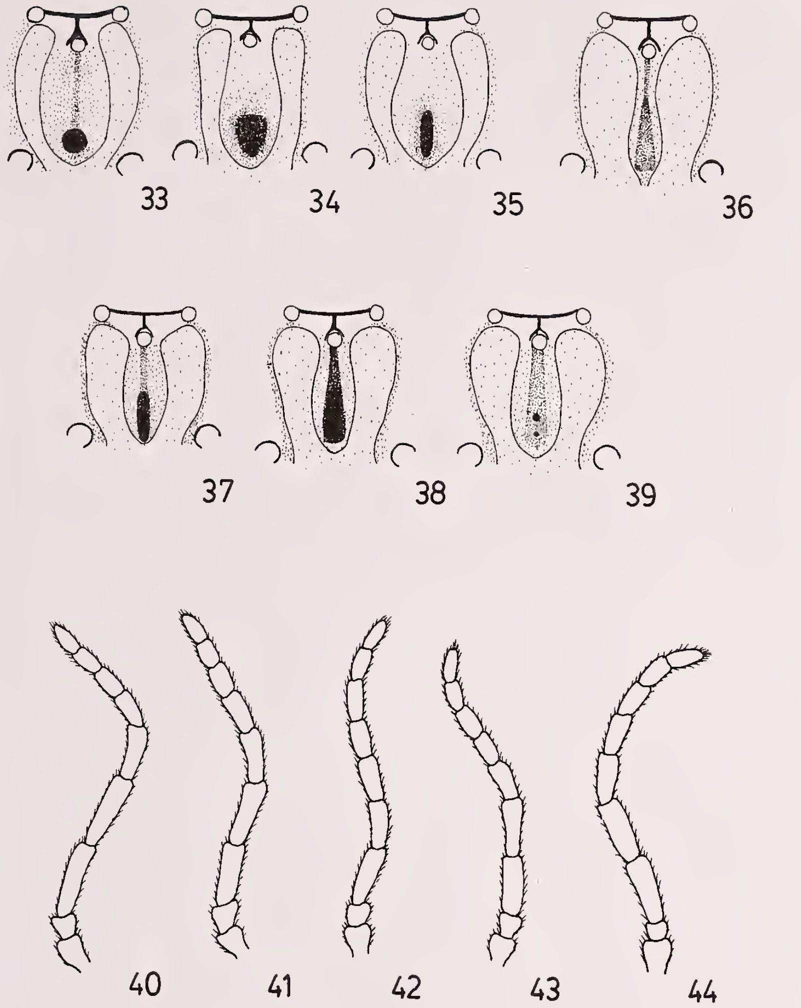
Etymology: Species name pertains to the very fine punctures present on body.

Ungulia himalayaensis sp. nov.
(Figs. 7, 13, 19, 29, 36, 42)

FEMALE: *Colour:* Body black, yellowish white are: clypeus except base; labrum; mandible base; posterodorsal angles of pronotum; a broad triangular spot on lower posterior part of mesepisternum; deflexed lateral sides of tergites 3-6; all sternites entirely; all legs except fuscus tarsi. Wings infumated, venation including costa, subcosta and stigma piceous.

Structure: Average length 6.5 mm. Antenna (Fig. 42) 2.3X head width; scape as long as its apical width; pedicel 1.3X its apical width; segment 3 shorter than 4 as 6:7; clypeus (Fig. 2) shallowly, circularly emarginate with wavy anterior margin; labrum broader than long as 2:1, with deflexed rounded anterior margin; malar space 1.75X diameter of median ocellus and as long as pedicel; LID:IDMO:EL = 3:3:2; median fovea (Fig. 36) in form of a shallow triangular pit in its anterior half and posteriorly only shallowly reaching median ocellus; post-, inter-, and circum-ocellar furrows sharp and distinct; lateral furrows deep, distinct, diverging backwards and ending well before hypothetical hind margin of head; postocellar area broader than long as 4:3; OOL:POL:OCL = 5:4:5; mesoscutellum subconvex; appendage not carinated; metabasitarsus equal to following joints combined; IATS:MB:OATS = 2:5:1.5. Lancet (Fig. 29) with 15 serrulae. Hypopygium as in Fig. 7.

Sculpture and pubescence: Head and thorax almost impunctate except a few scattered, minute punctures, surface shining with general



Figs. 33-39. Head (Front view of median fovea): 33. *U. auratica* sp. nov.; 34. *U. fasciativentris* Malaise; 35. *U. acupunctata* sp. nov.; 36. *U. himalayaensis* sp. nov.; 37. *U. brevis* sp. nov.; 38. *U. nigritarsis* (Cameron); 39. *U. scutopunctatus* sp. nov.; 40-44; Antenna: 40. *U. auratica* sp. nov.; 41. *U. fasciativentris* Malaise; 42. *U. himalayaensis* sp. nov.; 43. *U. brevis* sp. nov.; 44. *U. scutopunctatus* sp. nov.

oily lustre; abdomen impunctate, subshining. Body covered with silvery pubescence.

MALE: Average length 4.5 mm. Similar to female. Male genitalia: Penis valve (Fig. 19), gonoforceps (Fig. 13).

Material examined: *Holotype:* Female, Uttar Pradesh, Dhanolti, 2200 m, 25.7.1993. *Paratypes:* Uttar Pradesh, Auli, 2400 m, (1 ♀), 27.6.1992; Munsyari, 2300 m, (1 ♀), 19.6.1993; Binayak, 2200 m, (1 ♂), 22.6.1993; Dhanolti, 2200 m, (1 ♀, 1 ♂), 25.7.1993.

Population variation: Not observed.

Distribution: INDIA: Uttar Pradesh.

Diagnostic combinations: Entirely black abdomen is sufficient to separate *U. himalayaensis* from *U. auratica* and *U. fasciativentris* (tergites 2-5 entirely auratus in former, but 2-5 with broad medial auratus spot in latter). It is distinct from *U. brevis*, *U. nigritarsis*, and *U. scutopunctatus* on the basis of antennal segments 3 and 4 as 6:7 (equal in all three); malar space less than 2X diameter of median ocellus (2X or more in all the three); median fovea triangular, pit-like, shallowly reaching median ocellus (ditch-like shallowly reaching median ocellus in *U. brevis* and *U. scutopunctatus* but deep ditch-like clearly reaching median ocellus in *U. nigritarsis*.

Etymology: Named after the great 'Himalaya' in which its localities fall.

Ungulia brevis sp. nov.

(Figs. 11, 16, 22, 30, 37, 43)

FEMALE: *Colour:* Body black, yellowish white are: clypeus except extreme base; labrum; posterodorsal angle of pronotum; a broad triangular spot on lower posterior 1/2 of mesepisternum; all sternites entirely; all legs except tarsi which are light brownish. Wings infumated; venation including costa, subcosta and stigma light to dark brown.

Structure: Average length 4.5 mm. Antennae (Fig. 43) 2.7X head width; scape as long as its apical width; pedicel half as long as its apical width; segments 3 and 4 equal; clypeus (Fig. 1) circularly incised up to 1/3 of its medial length; labrum broader than long as 2:1, with deflexed rounded anterior margin; malar space 2X diameter of median ocellus and as long as pedicel; LID:IDMO:EL = 5:6:4; median fovea (Fig. 37) ditch-like in its anterior half and posteriorly only shallowly reaching median ocellus; post-, inter-, and circum-ocellar furrows sharp and distinct; lateral furrows deep, distinct, diverging backwards and ending well before hypothetical hind margin of head; postocellar area subconvex, broader than long as 2:1; OOL:POL:OCL=5:4:4; mesoscutellum subconvex; appendage not carinate; ICD:ITD: 1:3; metabasitarsus shorter than following joints combined as 4:5; IATS:MB:OATS = 0.75:0.5:2.0. Lancet (Fig. 30) with 14 serrulae. Hypopygium as in Fig. 11.

Sculpture and pubescence: Head impunctate, shining; mesonotum and mesoscutellum with dense, minute, irregular, inconspicuous punctures, surface shining; appendage impunctate, polished; mesepisternum and mesosternum almost impunctate, polished; surface shining with general oily lustre; abdomen impunctate, subshining. Body covered with silvery pubescence.

MALE: Average length 3.5 mm. Similar to female. Male genitalia: Penis valve (Fig. 22), gonoforceps (Fig. 16).

Material examined: *Holotype:* Female, Arunachal Pradesh, Bomdila, 2550 m, 9.5.1992. *Paratypes:* Arunachal Pradesh, Bomdila, 2550 m, (2 ♀♀, 5 ♂♂), 9.5.1992.

Population variation: Outer aspects of tibiae may be faintly brownish.

Distribution: INDIA: Arunachal Pradesh.

Diagnostic combinations: Postocellar area broader than long as 2:1 (3:2 in *U. nigritarsis* and *U. scutopunctatus*), pedicel 1/2 of its apical width (as long as its apical width in *U. nigritarsis* and *U. scutopunctatus*) and clypeus emarginate up to 1/3 of its medial length (only shallowly emarginate in *U. nigritarsis* and *U. scutopunctatus*) are the character which keep *U. brevis* distinct from these two species. On the basis of antennal segments 3 and 4 equal (subequal in *U. acupunctata* and *U. himalayaensis*), malar space 2X diameter of median ocellus (less than 2X diameter in *U. acupunctata* & *U. himalayaensis*, median fovea ditch-like in anterior 1/2 and posteriorly shallowly reaching median ocellus (ditch-like in anterior 1/2 but posteriorly not reaching median ocellus in *U. acupunctata* and triangular pit-like in *U. himalayaensis*, this species remains distinct from its closely related species. Colour pattern of abdomen of this species which is entirely black separates it from *U. fasciativentris* (tergites 2-5 with broad medial auratus spot) and *U. auratica* (tergites 2-5 auratus entirely).

Etymology: Species name pertains to small size of its body.

Ungulia nigritarsis (Cameron, 1902)
(Figs. 3, 10, 14, 20, 31, 38)

Taxonus nigritarsis Cameron, 1902, *J. Bombay nat. Hist. Soc.; 14:* 443.

U. nigritarsis (Cameron) Malaise, 1961. Ent. Tidskr; Arg, 82, Hafte 3-4: 244.

FEMALE: *Colour:* Body black, yellowish white are: clypeus except base; labrum; mandible base; a broad triangular spot on lower posterior 1/2 of mesepisternum; all sternites; all legs except tarsi which are light to dark brownish. Wings infumated; venation including costa, subcosta and stigma piceous.

Structure: Average length 6 mm. Antenna (Fig. 44) 2.3X head width; scape and pedicel as long as their apical widths; segments 3 and 4 equal; clypeus (Fig. 3) shallowly circularly emarginate with wavy anterior margin; labrum (Fig. 3) broader than long as 2:1, with slightly deflexed rounded anterior margin; malar space 2.5X diameter of median ocellus and 1.5X pedicel length; LID:IDMO:EL = 3:3:2; median fovea (Fig. 38) ditch-like in its anterior half and posteriorly clearly reaching median ocellus; post-, inter-, and circum-ocellar furrows sharp and distinct; lateral furrows deep, distinct, diverging backwards and ending well before hypothetical hind margin of head; postocellar area subconvex, broader than long as 3:2; OOL:POL:OCL = 4:4:5; mesoscutellum subconvex, appendage not carinated; ICD:ITD = 2:7; metabasitarsus shorter than following joints combined as 6:7; IATS:MB:OATS = 0.75:3:1. Lancet (Fig. 31) with 14 serrulae. Hypopygium as in Fig. 10.

Sculpture and pubescence: Head impunctate, shining; thorax with dense, fine, irregular, inconspicuous punctures, except impunctated appendage, surface shining with general oily lustre; abdomen impunctate, subshining. Body covered with silvery pubescence.

MALE: Length 4.5 mm. Similar to female. Male genitalia: Penis valve (Fig. 20), gonoforceps (Fig. 14).

Holotype depository: Male, BMNH, London.

Paratype depository: 1 ♀, NR Stockholm.

Specimens examined: Arunachal Pradesh, Bomdila, 2550 m, (4 ♀♀), 13.9.1992; Nine mile, 1200 m, (2 ♀♀, 1 ♂), 14.9.1992. Meghalaya, Smit, 1500 m, (1 ♀), 5.9.1993.

Population variation: Posterodorsal angle of pronotum may be whitish yellow.

Distribution: INDIA: Arunachal Pradesh, Meghalaya.

Diagnostic combinations: *U. nigritarsis* (Cameron) is unique in having deep ditch-like median fovea posteriorly clearly reaching median ocellus, malar space 2.5X diameter of median ocellus and 1.5X pedicel length, OOL:POL:OCL=4:4:5 and thorax with dense, fine, irregular punctures. The combination of these characters separates it from all species of this genus.

Ungulia scutopunctatus sp. nov.
(Figs. 4, 9, 18, 25, 32, 39, 44)

FEMALE: *Colour:* Body black, yellowish white are: clypeus except base; labrum; posterodorsal angle of pronotum; a triangular spot on lower posterior 1/2 of mesepisternum; all sternites entirely; all legs except apices of all tibiae and tarsi which are fuscus. Wings infumated; venation including costa, subcosta and stigma piceous.

Structure: Average length 6.5 mm. Antenna (Fig. 44) 2.2X head width; scape and pedicel as long as their apical widths; segments 3 and 4 equal; clypeus (Fig. 4) slightly emarginate; labrum (Fig. 4) broader than long as 3:1, with slightly deflexed and truncate anterior margin; malar space 2X diameter of median ocellus and 1.2 X pedicel length; LID:IDMO:EL = 3:3;2; median fovea (Fig. 39) shallow ditch-like in its anterior half and posteriorly shallowly reaching median ocellus; post-, inter-, and circum-ocellar furrows sharp and distinct; lateral furrows distinct, diverging backwards and ending abruptly just before hypothetical hind margin of head; postocellar area almost flat, broader than long as 3:2; OOL:POL:OCL = 4:4:3; mesoscutellum subconvex; appendage not carinate; ICD:ITD = 2:7; metabasitarsus shorter than following joints combined as 6:7; IATS:MB:OATS = 1:3:1. Lancet (Fig. 32) with 13 serrulae. Hypopygium as in Fig. 9.

Sculpture and pubescence: Head, thorax and abdomen impunctate except a few shallow punctures on posterior slope of mesoscutellum, surface shining. Body covered with silvery pubescence.

MALE: Average length 4 mm. Similar to female. Male genitalia: Penis valve (Fig. 25), gonoforceps (Fig. 18).

Material examined: *Holotype:* Female, Sikkim, Gangtok, 1500 m, 14.5.1993. *Paratypes:* West Bengal, Darjeeling, 2280 m, (2 ♀♀, 1 ♂), 7.5.1993.

Population variation: Not observed.

Distribution: INDIA: Sikkim, West Bengal.

Diagnostic combinations: *U. scutopunctatus* resembles *U. nigritarsis* on the basis of some broad key characters such as: abdomen entirely black; postocellar area broader than long as 3:2; pedicel as long as its apical width; clypeus shallowly emarginate and antennal segments 3 and 4 equal, but differs from it in having malar space 2X diameter of median ocellus (2.5X in *U. nigritarsis*) and 1.2X pedicel length (1.5X in *U. nigritarsis*), median fovea shallow ditch-like in its anterior 1/2 and shallowly reaching median ocellus (deep ditch-like, clearly reaching median ocellus in *U. nigritarsis*) and OOL:POL:OCL = 4:4:3 (4:4:5 in *U. nigritarsis*).

Etymology: Species name refers to the presence of punctures on mesoscutellum.

ACKNOWLEDGEMENTS

We thank Dr. D.R. Smith of USNM, Washington for his valuable suggestions. Financial assistance rendered by US, PL-480 in collaboration with ICAR, New Delhi is also acknowledged.

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MISCELLANEOUS NOTES

1. CLAW MARKING ON TREES BY TIGER *PANTHERA TIGRIS* (LINN.) IN KANHA NATIONAL PARK

INTRODUCTION

Tiger is a territorial animal and usually leads a solitary life. The intrasexual territories are maintained by advertisement - both olfactory as well as visual. These signals are perceived by the conspecifics and thus internecine strife is avoided in nature. Scent marking, defecation and scratching on the ground, vocalisation, cheek rubbing on trees are some of the common territory marking methods. Some studies have been conducted on the scent marking, pheromones and olfaction in tiger (Brahmachary and Dutta 1979, Chaudhury 1979) but observations on claw marking by tiger are few.

MATERIAL AND METHOD

The study was conducted in the Kanha National Park. Trees having tiger claw marks were located by intensive field survey. The tree species, girth, height of claw marks from the ground were recorded (Kotwal 1987) during 1980 to 1984 on specified roads as mentioned in the table. The distance of marked trees on different roads was also measured. The observations were repeated during the study period.

RESULTS AND DISCUSSION

The results are shown in the Table 1. Tigers frequently used *Madhuca longifolia* (19 trees) and *Pterocarpus marsupium* (7 trees). *Boswellia serrata* and *Bombax ceiba* were sparing used. The girth of marked trees varied from 37 cm to 324 cm. The height of claw marks from the ground level varied from 65 cm to 270 cm. These marked trees were about 1-5 km. apart on different roads and apparently belonged to different tigers (probably of both sexes) as the observations were made along 5 different routes. In one observation made at Bastar, an aberrant tigress (man-eater) had clawed trees like *Lagerstroemia parviflora* and *Tectona grandis*. It is noteworthy that trees with soft bark having a good amount of sap were frequently clawed, whereas those having rough bark *Shorea robusta,* etc. were avoided, though present in abundance.

TABLE 1
SHOWING TIGER CLAW MARKS ON DIFFERENT TREE SPECIES

Tree species	Girth (cm)	No. of trees used	Height of marks from ground level (cm)	Road length
I. *Boswellia serrata*	142	1	94 to 218	4 km.
Madhuca longifolia	152 to 211	5	75 to 221	Magar Nullah-Sondhar road
Pterocarpus marsupium	200	1	67 to 222	
II. *Madhuca longifolia*	37 to 161	6	80 to 225	6 km. Magar Nullah-Sondhar road
III. *Madhuca longifolia*	251	1	65 to 215	4 km. Sondhar-Ronda road
Pterocarpus marsupium	64 to 251	3	78 to 225	
IV. *Madhuca longifolia*	106 to 324	7	97 to 220	14 km. Sondhar-Kariwah road
Pterocarpus marsupium	130 to 170	3	120 to 270	
V. *Bombax ceiba*	340	1	75 to 230	Bamni dadar road

Smith *et al.* (1989) have reported clawing in both the sexes for territory marking. It is also believed that this action may perhaps sharpen the claws by peeling off any thin, loose or desquamated strips of laminae from the surface that are ready to flake off, either on the top of the claw or along the sides and thickened margins (Wyne-Edwards 1962). Probably this action also strengthens the claws and its muscles which are important to the predator for holding and tearing the prey. Schaller (1967) did not notice this phenomenon during his study (1964-66). Nevertheless clawing on trees is regularly discernible and appears to play an important role in territorial advertisement amongst tigers.

July 29, 1994

P.C. KOTWAL[1]
G.P. MISHRA[2]
[1] *Research Officer, Kanha Tiger Reserve, M.P.*
[2] *Professor of Botany, Sagar University, M.P.*

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2. AGGRESSIVE BEHAVIOUR OF A THIRSTY LEOPARD, *PANTHERA PARDUS* (LINN.)

There is a small spring called Kooda-ka-Joira situated high up in the hills about 20 km north-west of Udaipur. In fifties, the jungles around this spring were teeming with Four horned antelope (*Tetracerus quadricornis*), sambar (*Cervus unicolor*) and wild pigs (*Sus scrofa*). All these wild ungulates have been poached. Carnivores of the region (e.g. leopard and wolf *Canis lupus*)-chiefly depend upon live stock.

On 21st April, 1991 late in the evening our family went to the spring for an outing. Leaving the jeep about 200 m from the spring we walked down the remaining part and settled on an open patch near the water.

As darkness approached, we lit a carbide lamp and were enjoying the silence of the night. Suddenly we heard the low growl of a leopard from undergrowth 20 m from us. My father, who has many years of experience in the jungle, was worried and asked us to vacate the place immediately. But we were reluctant to do this and specially as the children were keen to see the leopard. Soon we found that the growling increased in intensity and the leopard started circling us and my father said that it is very dangerous now and we should quickly leave the place.

We hastily packed up our belongings and meanwhile the growl changed into a loud cough. For illumination we had only two pencil torches and a carbide lamp. As we prepared to depart, my elder brother took three or four steps away from us to pick up the lamp. At the same moment, with an ear-splitting cough the leopard broke cover and charged towards my brother. We all including my brother remained where we were. The leopard stopped about 13 feet from my brother, hissing, growling and lashing its tail. How long this state remained I can't say but probably less than a minute. The leopard slowly turned its head, leaped into a bush and disappeared from our sight. My brother quickly picked up the lamp and we retreated hastily towards the jeep.

My father explained that the leopard was very thirsty and was in dire need of water. The other source of water was about 3 km away. Because we were close to the spring, it warned us by growls to leave the place and when we were reluctant to do so, the leopard desperately charged towards us. Next day morning we found that the leopard had drunk from the pool.

The incident explains how such encounters could become dangerous.

October 19, 1994 RAZA TEHSIN

41, Panchwati, Udaipur 313 001,
Rajasthan.

3. CANNIBALISM IN SOUTH INDIAN PALM SQUIRREL *FUNAMBULUS PALMARUM* (LINN.)

INTRODUCTION

Rodents, namely rat and squirrels are the most important vertebrate pests that can cause enormous losses to food grains in the field and in storage. They are serious pests of coconut in almost all 76 coconut growing countries in the world including India and its islands. Though they are pests of cultivated crops and stored products, cannibalistic behaviour has been reported among them. Petter (1968) noted cannibalism in rats and mice. Cannibalism has been recorded in five striped squirrel, *Funambulus pennanti* Wroughton (Gupta and Agrawal 1968), captive Indian Gerbil, *Tatera indica indica* Hardwicke (Purohit 1977) and western ghats squirrel, *Funambulus tristriatus* Waterhouse (Bhat 1980). The factors inducing cannibalism in house rat, *Rattus rattus rufescens* Gray was studied by Purohit and Bohra (1973). During an *in vitro* investigation cannibalism was observed in south Indian palm squirrel, *Funambulus palmarum* Linn. at Coconut Research Station, Veppankulam in 1992. As cannibalism has not been reported in south Indian palm squirrel, a separate study was undertaken for confirming cannibalism in this species.

MATERIALS AND METHODS

Adult squirrels of *F. palmarum* trapped alive in the coconut plantations were used for the study. The sexes were separated. Two males were put in a netted iron cage (60 x 45 x 30 cm). This was replicated three times. Likewise two females constituting another pair were allowed in a similar cage and this was also replicated three times. In total six pairs, namely 3 pairs consisting 2 males each and another 3 pairs consisting 2 females each were individually maintained in separate iron cages. These were provided with coconut kernel and bananas.

RESULTS AND DISCUSSIONS

Among the six pairs, cannibalism was observed in all the three male pairs within 24 hrs of putting them in the cage. Cannibalism started during night. The head was eaten completely overnight. This was not observed in the females during the experimental period of 14 days. The presence of cannibalism is in conformity with the findings in captive desert gerbil, *Meriones hurrianae* Jerdon (Prakash and Kumbakarni 1962), five striped squirrel, *F. pennanti* (Agrawal 1965; Gupta and Agrawal 1968), Arctic squirrel, *Spermophilus parryii* (Holms 1977) and western ghat squirrel *F. tristriatus* (Bhat 1980).

December 5, 1994 S. SADAKATHULLA[1]
A. ABDUL KAREEM[2]

[1]Agricultural College & Research Institute,
Tiruchirappalli, 620 009,
Tamil Nadu.
[2]Centre for Plant Protection Studies,
Tamil Nadu Agricultural University,
Coimbatore 641 003.

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[An obviously aberrant behaviour under *captive* conditions and not to be interpreted as happening in the wild - Editors.]

4. AN APPROACH-BLOCKING DISPLAY BY A FIVE-STRIPED PALM SQUIRREL *FUNAMBULUS PENNANTI* (WROUGHTON) TO A HOUSE CROW *CORVUS SPLENDENS*

(*With a text-figure*)

Both the five-striped palm squirrel and the house crow are thriving species (Roberts 1977, 1992) but little has been published about their respective behaviour. Therefore, the following observation probably concerns a frequent as well as unstudied behavioural interaction.

On 22 August 1993 I was in Karachi, Pakistan. Towards sunset, I was observing and (through a 500 mm lens) photographing some five-striped palm squirrels wandering on a building of the Sheraton Hotel. A house crow suddenly alighted at some metres from one of these animals (probably out of sight of it) and hopped towards it. The squirrel soon presented the crow with its hind quarters, raising and bristling its tail. The tail was deliberately waved with an approximately lateral motion. The crow had its approach blocked at the distance shown in Fig. 1. The squirrel repeatedly turned its head from side to side but always presented the crow with a caudal image of itself, also when the bird tried a lateral move. The squirrel held the tail raised, waving it intermittently, and held its position until, half a minute later, the crow flew away. Considering the distance of the interacting animals from me (about 40 m) and the tameness of local house crows, I exclude a disturbing effect of my presence. Nor could I detect any other possible interference accounting for what appeared as an attack failure.

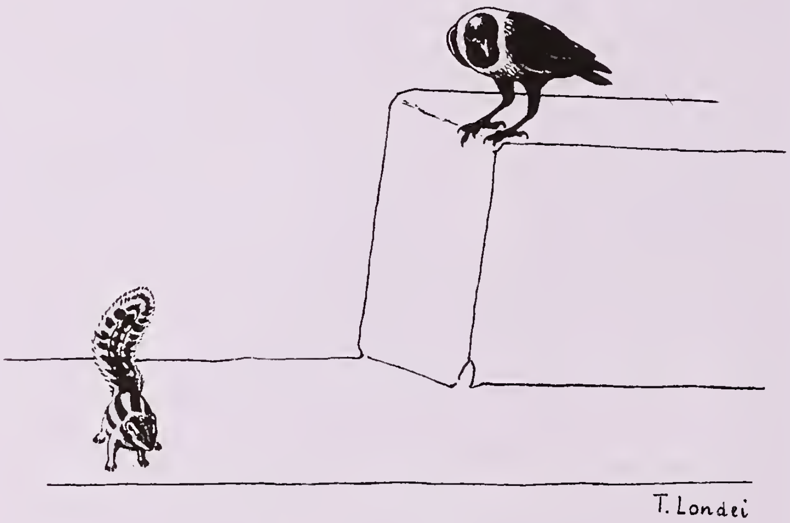

Fig. 1. The observed display.

This tail movement was similar to tail flagging by the California ground squirrel *Spermophilus beecheyi* (compare, in particular, with Fig. 1 in Hennessy *et al.* 1981), which is primarily used during interactions with snakes. However, California ground squirrels usually present the potential predator with a frontal, and not caudal, image while flagging their tails. This difference may be important for both the original and derived functions of the behaviour in question. There are only suggestions that tail flagging may be used to manage the behaviour of the predator (see Hersek and Owings 1993 for an up-to-date review of the various functions of tail flagging). Conversely, the tail movement I observed clearly indicated the crow as a target, not only because of the reactions of the bird, but also because I detected no reaction by the other two or three squirrels that could see this display. Of course repeated observations will be necessary to exclude any casual concomitance, but students should be encouraged by the fact that the house crow does eat squirrels (Ali and Ripley 1987), hence this display pattern may well have evolved in response to predation.

The observed approach-blocking effect probably depended on a sudden change in the image of the potential prey. This is a defensive mechanism widespread in animals, and some species potentiate the change effect by mimicking a dangerous species. Such may have been the case because the waving tail reminded me of a snake. The colouration of the five-striped palm squirrel is interesting in this respect, as longitudinal stripes give the whole body an elongated appearance, maybe more deceiving when the head and trunk are partly concealed by caudal presentation and the turning head alternately appears on either side. In addition, the tail possesses transversal stripes (often more marked than in the individual in Fig. 1) recalling a ringed snake body.

April 15, 1994

TIZIANO LONDEI
Departmento di Biologia,
Sezione di Zoologia e Anatomia Comparta,
Università di Milano, Via Celoria 26,
20133 Milano, Italy.

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5. OCCURRENCE OF BHARAL *PSEUDOIS NAYAUR* (HODGSON) IN THINGBU CIRCLE OF TAWANG DISTRICT OF ARUNACHAL PRADESH

On the basis of information available from local people, on 6th September 1990 I set out from my camp at Mago village with the village head, Gaon Buda, and one other youth of the village, to see bharal (locally called Jungli Bhaid). After trekking up the hill along the right bank of Dugong river for about 2 hours, the local youth observed some movement more than a kilometer away as the crow flies. On looking through binoculars, I observed that the animals were bharal. There were about 10 bharal, most of them relaxing in the Sun and others grazing. They remained in the same location for an hour then suddenly got alarmed and started moving up and eventually disappeared from view.

The highest hill near Mago village is 4770 m and the approximate altitude of Mago village is about 3800 m. The hill we climbed had the tree line near the base which finally gives way to alpine pastures. These pastures are used by domesticated yaks from July to October each year. According to locals bharal come down at night for drinking water in the Dugong river and early in the morning they start going up the hill. In the evening I visited the village and found bharal horns and skin, besides skin of the animals such as goral and Himalayan black bear.

According to Prater (THE BOOK OF INDIAN ANIMALS) though bharal are typical Tibetan animals they are also found in Ladakh, Kumaon Himalayas, Nepal, Sikkim and Bhutan. On that basis this is the first report of its occurrence in western Arunachal Pradesh. How much farther its range goes into Arunachal Pradesh is still to be determined.

October 19, 1994

PRATAP SINGH
Deputy Conservator of Forests (WL),
Wildlife Wetlands Vigilance,
Itanagar 791 111, Arunachal Pradesh.

6. A NEW REPORT ON PIGMY HOG *SUS SALVANIUS* (HODGSON) FROM WEST BENGAL

In December, 1989 a meter high dome-shaped nest made of grass and other vegetation was seen in a grassland in Dhupjhora block of 8.61 sq. km Gorumara Wildlife Sanctuary. The nest was thought to be that of Pygmy hog (*Sus salvanius*). Pygmy hog has not earlier been reported from this sanctuary. On further enquiry it was found that a few such nests had been sighted by mahouts of the departmental elephants within the same block before. The forest is a 'low alluvial savannah woodland' (Champion and Seth 1968). Other notable fauna of the Sanctuary are: the Indian rhinoceros *(Rhinoceros unicornis)*, gaur (*Bos gaurus*), hog deer (*Axis porcinus*), and tiger (*Panthera tigris*). Some Black-necked storks (*Xenorhynchus asiaticus*) were also present.

October 19, 1994 P. SANYAL

Asst. Chief Conservator of Forests, West Bengal,
P-16, Indian Exchange Place Extn.,
Near C.I.T. Building, Calcutta 700 073.

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CHAMPION, H.G. & S.K. SETH (1968): A revised survey of the forest types of India. Government of India, New Delhi.

7. FEEDING BEHAVIOUR OF LONGTAILED TREE MOUSE *VANDELEURIA OLERACEA* (BENNETT) AND INDIAN DESERT GERBIL *MERIONES HURRIANAE* ON SYNCARPS OF *XANTHIUM INDICUM* KOENIG

(*With three text-figures*)

The Longtailed tree mouse (*Vandeleuria oleracea*) is a facultative arboreal rodent, often seen living in the nests of *Ploceus philippinus* (Ali and Ambedkar 1956, Ambedkar 1980), *P. megarhynchus, P. benghalensis* and *P. manyar* (Ambedkar 1968). The Indian Desert Gerbil (*Meriones hurrianae*) is an obligatory terrestrial rodent, never seen climbing trees or to take refuge in the nests of weaver birds. Though both the rodents prefer different habitats, they feed on the cypsels of *Xanthium indicum* and have characteristic gnawing patterns of their own.

Xanthium indicum is a foetid smelling weed, which grows gregariously in fallow and agriculture lands. Like other members of Asteraceae, this plant bears a compound capitulum type of inflorescence. Its fruit is of the cypsela type. Two cypsels develop in each capitulum. Both the cypsels of a capitulum are included in the hardened spiny involucre, at maturity known as syncarp. Besides many are present at the apex.

The sessile syncarp is 2-celled, having a cypsel in each chamber. The unequal chambers have a septa between them. The two terminal massive spines occur at right angles to the septa of the syncarp (Fig. 1). When the syncarp is divided into two halves along the septa, each half gets one terminal spine and only one cypsela gets exposed (Fig. 2). While it is divided across the septa, both the terminal spines are split, each half gets split in the same plane and both the cypsels are exposed (Fig. 3).

This study of the gnawing behaviour of *V. oleracea* and *M. hurrianae* on *X. indicum* were conducted in the districts of Alwar and Jaipur. Their gnawing habits are described below.

Gnawing pattern of *V. oleracea*: As many as 222 residues of syncarps, gnawed by *V. oleracea* were collected at random from old nests of *Ploceus philippinus* and the cages of captive mice for sampling. *V. oleracea* avoids both 'basal' as well as 'terminal' gnawing, and starts gnawing from the middle of the syncarp. First all the smaller spines are removed, then the dried shield of the involucre is gnawed to expose one or both the cypsels.

Examination of the 222 gnawed syncarps

revealed that *V. oleracea* adopts three patterns of gnawing (Table 1).

TABLE 1

GNAWING PATTERNS SHOWN BY *V. OLERACEA*

Serial No.	Gnawing pattern		
	A	B	C
1. Gnawed syncarps	137	55	30
2. % of gnawed syncarps	61.71	24.77	13.51

(A = gnawing parallel to septa, B = gnawing across septa, C = intermediate gnawing)

1. Gnawing parallel to septa: This is the most preferred gnawing pattern and starts parallel to the septa. Hence at a time only one cell is opened. When the cypsel of one chamber is eaten the septa is gnawed to open the next chamber for the second cypsel. When the syncarp is gnawed thus, generally one terminal spine is left behind on the remaining portion of the syncarp.

2. Gnawing across septa: This is a less preferred method of gnawing which starts across the septa just at the point where the septa joins the involucre, and results in both the cells getting opened. When this method is adopted generally both the terminal spines may be found intact on the last remaining piece of the syncarp.

3. Intermediate gnawing: This is an intermediate condition of both patterns described earlier. In this method, both the chambers are opened at a time but gnawing begins at A or B or C or D.

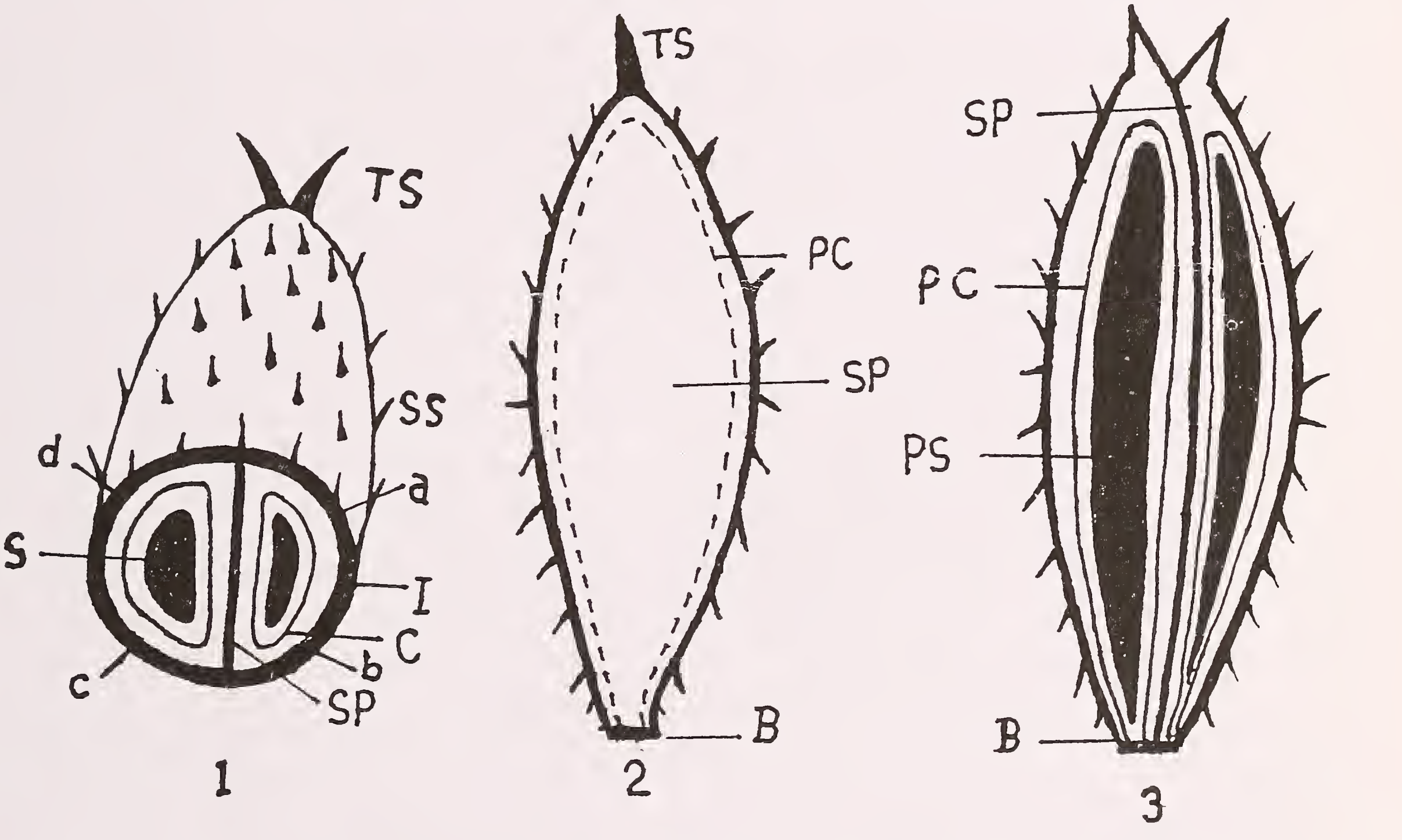

Fig. 1. Upper half of syncarp of *Xanthium indicum* in T.S. : septa is situated at right angle to the terminal spines. Fig. 2. View of either half of the syncarp of *Xanthium indicum* in L.S. when bisected along the septa. Fig. 3. View of the either half of the syncarp of *Xanthium indicum* in L.S. when bisected across the septa.

Abbreviations: TS: Terminal spines; SS: Small spines; I: Involucre cover; C: Cypsela; SP: Septa; S: Seed; B: Base of syncarp; PC: Position of cypsela; PS: Position of seed; a, b, c, d: Points on involucre cover where 'intermediate' gnawing is started.

Gnawing pattern of ***M. hurrianae:*** Unlike *V. oleracea*, *M. hurrianae* gnaws the basal portion of the syncarp. Almost the entire lower half is gnawed to devour both the cypsels leaving behind the terminal spines intact. Perhaps to avoid the terminal spines, 'basal eating' is preferred by this rodent.

CONCLUSION

It is clear that *V. oleracea* and *M. hurrianae* have characteristic patterns of gnawing syncarps of *X. indicum* and both avoid the terminal larger spines. By seeing a gnawed syncarp of *X. indicum* one could get a clue whether it is eaten by *V. oleracea* or *M. hurrianae*. It is also worthy to record that in times of scarcity, seeds of weeds like *X. indicum* are used by rodents. Thus, they help in weed control also.

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October 19, 1994 SATISH KUMAR SHARMA
Range Forest Officer,
Aravalli Afforestation Project,
Jhadol (F.), Dist. Udaipur,
Rajasthan 313 702.

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8. INTERACTION BETWEEN BLACKBUCK *ANTELOPE CERVICAPRA* (LINN.) AND INDIAN FOX *VULPUS BENGALENSIS* (SHAW)

On 8th February 1991, at dusk Mr. Rajpal Singh and I were sitting near artificial water hole at the Tal Chhapar Blackbuck Sanctuary in Rajasthan, watching a mixed herd of blackbuck grazing about 200 m away. Separated from the main herd, and about a 100 m from us was a party of four bucks grazing. These four were gradually moving towards us, spaced about 3 to 5 m from each other.

When it was about to get dark we saw an Indian fox midway between the mixed herd and the buck party, trotting through the grass towards us. As it passed close to the bucks, the buck nearest to it rushed towards the fox with lowered head. The fox changed its course to avoid the blackbuck and came again towards the water. When it again passed near the bucks, one of the bucks chased the fox for a long distance till it disappeared in the grass. During these interactions no alarm was shown by the herd but the other three members of the buck party assumed an alert posture with neck held vertically.

November 8, 1994 ASHOK KUMAR SHARMA
D-67, Sawai Madho Singh Road,
Bani Park, Jaipur 302 016.

9. PROBABLE OCCURRENCE OF WHITEFRONTED GOOSE *ANSER ALBIFRONS* (SCOPOLI) IN ANDHRA PRADESH

The Rollapadu Wildlife Sanctuary (*c.* 15° 52', 78° 18' E), Kurnool district, Andhra Pradesh harbours a few hundred Barheaded geese *Anser indicus* every winter. Whenever I came across a flock during my earlier stay in the Sanctuary between 1985 and 1988 I kept a watch for the Greylag geese, *Anser anser* which has not been recorded from here. However, during my present study period under the Grassland Ecology Project, on 31 October 1992 I saw a Whitefronted goose *Anser albifrons* with a flock of 17

Barheaded geese. I could clearly see the white patch on the forehead from the base of the bill. I did not notice or really look out for the presence of the yellow eye-ring present in the similar Lesser whitefronted goose *Anser erythropus*, but judging by its size, (threefourths of the Barheaded goose), it should be the Whitefronted goose and not the smaller Lesser whitefronted. There has been no record of both these geese from Andhra Pradesh, the southernmost record for the Whitefronted goose being Orissa and Maharashtra and for the Lesser whitefronted goose only Pune in Maharashtra (Ali and Ripley 1983, HANDBOOK OF BIRDS OF INDIA AND PAKISTAN, Compact Edition, Oxford University Press, Bombay).

June 11, 1993

RANJIT MANAKADAN
Bombay Natural History Society,
Hornbill House, Dr. Salim Ali Chowk,
Shaheed Bhagat Singh Road,
Bombay 400 023.

10. HARE IN THE DIET OF WHITE-EYED BUZZARD EAGLE *BUTASTUR TEESA* (FRANKLIN)

On 23rd May 1992 while walking through the grassland in Sathiana area of the Dudwa National Park, (28° 18' & 28° 42' N and 80° 28' & 80° 27' E) Lakhimpur Kheri, I observed a White-eyed buzzard eagle *Butastur teesa* swooping over some animal in the grass. Because of the tall grasses the animal was not identifiable. On closer approach I saw it feeding on a hare. As I moved closer the bird flew leaving a freshly killed hare on which it had been feeding. The hare was freshly killed as evident from the oozing blood, warm body and the small amount consumed. The bird had fed on the head, including the ears.

Two species of hare occur in Dudwa National Park, the highly endangered hispid hare *Caprolagus hispidus* and the sympatric rufous-tailed hare *Lepus nigricollis*. The killed hare was identified as rufous-tailed hare. Rats, mice, lizards, snakes, frogs, crabs, locust and grasshoppers and often larger insects have been reported in the diet of White-eyed buzzard eagle (Ali and Ripley 1983, HANDBOOK OF BIRDS OF INDIA AND PAKISTAN) but there is no report of any hare species in its diet.

July 31, 1993

SALIM JAVED
Bombay Natural History Society
Hornbill House, Dr. Salim Ali Chowk,
Shaheed Bhagat Singh Road,
Bombay 400 023.

11. UNUSUAL NESTING SEASON OF BRONZEWINGED JACANA *METOPIDIUS INDICUS* (LATHAM)

The breeding of Bronzewinged jacana *Metopidius indicus* (Latham) coincides with the arrival of south-west monsoon. The period given by Ali and Ripley (1983, HANDBOOK OF BIRDS OF INDIA AND PAKISTAN) and Roberts (1991, BIRDS OF PAKISTAN, 1) is June to September. This is the usual time when vegetation filled waterholes are a plenty, which form the nesting site for Bronzewinged jacana. In the altered city environs such opportunities are available outside the usual nesting season. The vegetation filled shallow tanks are either man made or caused by the seepage of irrigation reservoirs and canals. This availability of nesting site, food, high humidity due to unusual precipitation in the month of March, sparked off the breeding activity of Bronzewinged jacana in the centre of Kota city (75° 52' E, 25° 10' N) in Rajasthan, India. In a small pool close to Chhatravilas tank which acts as an irrigation reservoir, mating was seen on 16th March 1993 in the morning hours. The pool is choked with *Trapa* *bispinosa* and other submerged vegetation. Later the male was seen incubating the eggs and the female roamed the pool without taking part in the incubation. On 8th April two young chicks (approx. 12-15 cm) were seen with the couple. I took up extensive survey of the area on 14th April. Only one chick was seen with the male parent in the first pool. In an adjacent pool three adult sized chicks were seen. The chicks were about 25 cm in size with buff supercilium, yellow nape, buff coloration on head extending to the mantle and dark brown wings. In the first week of April, the inlet to the Chhatravilas tank had been closed and I found three nests of Bronzewinged jacana with four eggs in each nest. On the muddy drying margins, the eggs were placed on the mounds of rotting water hyacinth *Eichhornia crassipes* leaves and stems and merged very well with the background because of their glossy copper brown coloration scribbled with irregular black lines. On 18th April the Department of Irrigation started cleaning up operation in the tank causing loss of nests and eggs. Again mating activity was observed on the first pool in mid May. Although complete follow up was not done, two chicks (*c.* 15 cm) were seen on 9th June in the first pool. From this, it is clear that the man-altered environment provides suitable conditions, in some instances, causing changes in the normal breeding pattern of the Bronzewinged jacana.

I thank Dr. Asad R. Rahmani for his valuable comments on an earlier draft.

July 21, 1993

RAKESH VYAS
2-P-22, Vigyan Nagar,
Kota 324 005,
Rajasthan.

12. THE CRAB PLOVER, *DROMAS ARDEOLA* PAYKULL - AN ENIGMA

The Gulf of Kachchh littoral is perhaps the finest locale to watch this very attractive bird. During the cool season every major reef has a large flock. During low tide the birds scatter over wide area of mud singly and in pairs. This is how the bird apparently has been seen by earlier naturalists, Dr. Salim Ali and MKS Dharmakumarsinhji. It was during my visit to Pirotan Island in 1969 that the huge assemblies at high tide were observed. Dr. Salim Ali made a special visit to Pirotan to see the birds. Unfortunately, just as he came round a bend in the beach to where I had found a flock, a fisherman approached from the other side and the flock flew away low over the water to another island. Others have not only seen the large congregations but photographed them as well.

The Crab Plover is a very confiding bird and when resting at a selected beach - they seem to prefer clean sand to pass the high tide hours rather than rocks or mud - and can be approached extremely close. The birds are noisy, keeping up a continual clanging clamour. From time to time a flock may take off en masse and fly around in spectacular massed formations turning and twisting, rising and falling to skim over the waves and are a joy to watch.

Crab plovers are strong fliers, they fly along the shoreline, never crossing any land, howsoever small. Even a sand bar is not crossed, but skirted.

Among the clanging clamour can be heard the quivering notes of juveniles - one dingy bird to almost every pair of glistening adults. The enigma is, where do these large flocks breed so successfully?

March 31, 1992

LAVKUMAR KHACHER
646, Vastunirman,
Gandhinagar 382 022,
Gujarat.

13. ROSERINGED PARAKEETS *PSITTACULA KRAMERI* (SCOPOLI) FEEDING ON SEEDS OF KARVI *CARVIA CALLOSA* (NEES) BREMEK.

Thirteenth June was rather cloudy day with intermittent showers. As we were returning from a morning's ramble in the Borivli National Park, we heard the screechy clamour of a flock of parakeets squabbling over food. A closer look revealed a flock of Roseringed Parakeets, *Psittacula krameri* (Scopoli) plucking *Carvia callosa* heads and holding it in their toes.

As we approached closer to them they flew and the number was around 100 +. We could also identify a few Alexandrine Parakeets *Psittacula eupatria* among them.

Karvi mass-flowered in 1992. On the edge of the Karvi patch lay scattered broken off twigs and inflorescence. This happens to be an unrecorded item in the dietary of the Parakeet. Mr. J.S. Serrao informs us that he has observed the Roseringed in flocks breaking off portions of the branch with dried inflorescence of *Hyptis suaveolens* (L.) Poit. (*Vilayathi Tulsi*), carrying it to a nearby branch or an overhead wire, and perching thereon to feed on the seed.

July 13, 1993

NARESH CHATURVEDI
M.R. ALMEIDA
Bombay Natural History Society,
Hornbill House, Dr. Salim Ali Chowk,
Shaheed Bhagat Singh Road,
Bombay 400 023.

14. CRAB-EATING BY WHITEBREASTED KINGFISHER *HALCYON SMYRNENSIS* (LINN.)

On 24th December, 1992 while I was watching some waders in a nullah near our house at Panchwati in Udaipur City of Rajasthan, I saw a Whitebreasted Kingfisher dart into the shallows of the nullah and fly away with a crab in its beak. It perched on a Babool tree (*Acacia nilotica*), but remained only for a very short time and flew to the roof of a nearby house and started battering the crab on the roof. Probably disturbed, it again flew and settled in a high and dense part of the Babool tree. Here again it battered the crab on a branch and broke off a leg. It changed the position of the crab in its beak and started beating it on the branch of the tree. In this fashion it removed all the appendages of the crab in 13 minutes. Then it started to press the body of the crab in its beak. After 12 minutes of this labour it shaped the body of the crab to suit its gullet and gulped it down.

July 2, 1993

RAZA TEHSIN
38, Panchwati,
Udaipur 313 001,
Rajasthan.

15. LITTLE GREEN BEE-EATER, *MEROPS ORIENTALIS* LATHAM FEEDING ON CRABS

During my protracted stay on Beyt Dwarka last February at the southern entrance of the Gulf of Kachchh I repeatedly observed more than a dozen of the little Green Bee-eaters perched on drift wood, algae fronds and lumps of dead coral dashing low over the sand to pick off the small, white crabs that live all along the beach in great numbers.

April 29, 1993

LAVKUMAR KHACHER
646, Vastunirman,
Gandhinagar 382 022,
Gujarat.

16. UNUSUAL ESCAPE BEHAVIOUR IN GOLDENBACKED WOODPECKER *DINOPIUM BENGHALENSE* (LINN.)

While watching a pair of Goldenbacked woodpeckers (*Dinopium benghalense*) on 20th July 1993, I had an interesting observation. The pair was foraging on a coconut palm (*Cocos nucifera*) at a height of about 6 m from the ground, the male bird being approximately 1.5 m above the female.

A male Shikra (*Accipiter badius*) appeared, uttering his loud ringing calls and alighted on a tamarind tree nearby. The woodpeckers responded quickly. The male flew to a Jack tree (*Artocarpus heterophyllus*) promptly followed by the female. The Shikra still continued his loud calls, but could not be seen as he was hidden by the foliage.

The male woodpecker apparently unconcerned, clambered about on the jack tree and continued feeding. Meanwhile the female was nowhere in sight, but careful scanning revealed her clinging upside down on the lower side of a stout branch which was at an angle of 70° with the main trunk. The female remained in this seemingly awkward position for about 2 minutes without any movement. Later after the Shikra had flown away, she clambered up on the upper surface and joined her mate.

This pattern of escape behaviour is not common among woodpeckers and hence is noteworthy.

October 9, 1993

MANOJ V. NAIR
34, Thoppil Nagar,
Kumarapuram,
Trivandrum,
Kerala 695 011.

17. THE GREYTHROATED OR PLAIN SAND MARTIN *RIPARIA PALUDICOLA* VIEILLOT - A NEW BIRD FOR SOUTHERN INDIA

During the course of the Asian Wetland Counts, 1993, I came across at least five individuals of the Greythroated or Plain Sand Martin (*Riparia paludicola*) in the Kole Wetlands, near Thrissur town, Kerala. The birds were noticed flying over the wet and freshly ploughed paddy fields along with Common and Red-rumped Swallows (*Hirundo rustica* and *H. daurica*). The birds flew very low and quite close repeatedly, permitting a good view. The presence of the swallows enabled a good comparison of size and plumage. Photographs were taken and these enabled positive identification.

The birds were distinctly smaller than the swallows and had a short, less forked (almost squarish) tail. The overall plumage was dull. The upper parts were greyish brown with a conspicuously paler rump. The chin, throat and the upper breast were darker (brown or grey) than the whitish lower breast and belly. No markings or spots could be seen on the tail feathers. These features helped in identifying the birds as Greythroated Sand Martins.

I have seen these birds on an earlier occasion near Chilka Lake in February 1987 and am familiar with the superficially similar looking Collared Sand Martin (*Riparia riparia*), having seen it on several occasions in Madras, Lakshadweep, S. Arcot district (near Kaliveli Tank) and at Pulicat Lake environs (Andhra Pradesh).

The 'HANDBOOK' (Ali and Ripley 1983) records Maharashtra (Bombay, Nasik, Satara, etc.) and Orissa as the southern most range of this species and therefore the present sighting further south is noteworthy.

ACKNOWLEDGEMENTS

I thank S. Anitha, R. Nandakumar and Sanjeev Kumar who accompanied me on this occasion and R. Kannan for going through this manuscript and offering criticism.

June 24, 1993

V. SANTHARAM
68, First Floor,
Santhome High Road,
Madras 600 028.

18. *LANIUS CRISTATUS* LINN. IN KUTCH, GUJARAT - A WESTWARD EXTENSION

Lester in his 'The birds of Kutch' had mentioned the Brown Shrike as a cold weather visitor to Kutch. Salim Ali was of the opinion that it was not likely to be met with in this area. I have been seeing a shrike off and on in winter in my own compound here in Bhuj as also over the years in the plantation at Vijaya Vilas Palace (Mandvi). I think this bird fits in with the description of *Lanius cristatus* as regards its plumage and choice of habitat. Its behaviour too is different from the similar-coloured shrikes which are known to be met with in Kutch and its neighbourhood as either winter visitors or passage migrants. The bird in question keeps to bushes, fruit trees or hedgerows from which it launches sallies at its prey on the ground in typical shrike fashion; but does not perch on a tree or bush in an exposed position. Only collecting it or photographing it could help identify it.

As regards the distribution of *Lanius cristatus,* Ripley (SYNOPSIS) seems to follow the information of Vaurie. In the HANDBOOK the distribution is given as '......... roughly south and east of a line from Ahmednagar through the Surat Dangs (Gujarat), Mhow (Madhya Pradesh), Lucknow (Uttar Pradesh) and Nepal'. On the other hand Stuart Baker (FAUNA II) says: 'In winter it is found practically throughout Northern India as far as south as Mt. Abu ....'. The last is not far, as the crow flies, from north Gujarat and Kutch. Thus it would be interesting if there are any latest reports of sightings or firm records of this shrike's occurrence in districts of north Gujarat or Saurashtra.

November 3, 1993 HIMMATSINHJI

Jubilee Ground,
Bhuj, Kutch,
Gujarat.

19. FOOD STORING BEHAVIOUR OF THE JUNGLE CROW *CORVUS MACRORHYNCHOS* WAGLER

On 12th July 1993, I was at the forest check-post Falasia in Udaipur district. At about 11 a.m., I saw a Jungle crow *Corvus macrorhynchos* alighting on the tiling of a house beside the check-post. It was holding a dead half-eaten House rat *Rattus rattus* in its bill. Just after alighting on the tile-roof, it quickly placed the dead rat inside a small space, present beneath one of the tiles. It pulled the tile slightly ahead, holding it in its bill to cover the exposed part of the dead rat. The crow worked the tile this way and that, even then it was unable to hide the rat completely. After this 'trial and error' it inserted the tail of the rat forcefully under the tile. After placing the carcass of the rat the crow flew away to a neem tree.

Food-storing behaviour of the jungle crow has also been described by Natarajan (JBNHS 89: 375. 1992) at Pt. Calimere Sanctuary where he observed the crows hiding food material on ground and using the vegetation as cover.

November 3, 1993 SATISH KUMAR SHARMA

Range Forest Officer,
Aravalli Afforestation Programme,
Jhadol (F.), Udaipur 313 702,
Rajasthan.

20. YELLOWTHROATED BULBUL *PYCNONOTUS XANTHOLAEMUS* (JERDON) AT BILIGIRIRANGAN HILLS, KARNATAKA

Biligirirangan hills form a part of a discontinuous hill range running north to south, varying from 600-1800 m (above MSL). The hill range is located between Chamrajnagar, Yellandur and Kollegal in Mysore district of Karnataka, South India.

Biligirirangan hill (12° 08' N, 77° 00' E, 1280 m above MSL) with an ancient temple of Biligiri Rangaswamy at the summit, is a very famous pilgrimage centre. It forms the main tourist attraction of Biligiri Rangaswamy Temple Wildlife Sanctuary covering an area of 539.52 sq. km.

As a part of the survey on the status and distribution of yellowthroated Bulbul *Pycnonotus xantholaemus* (Jerdon) Dr. S. Subramanya and J.N. Prasad visited the B.R. hill ranges between 22-25 December 1990. During the survey, likely habitats in the sanctuary were visited, but the species was neither sighted nor was it heard.

On a subsequent visit to the Sanctuary, on 16 August 1992, we were birdwatching in the forests below the sheer rock on which the temple is situated. We were watching a pair of Shahin Falcons *Falco perigrinus perigrinator* Sundevall circling overhead and then fly past the rock face, when suddenly, the characteristic calls of the *P. xantholaemus* were heard. We traced the call to be coming from the densely foliaged *Ficus* which was growing amidst the crevices on the rocky escarpment below the temple. We waited with curiosity to have a look at the birds to confirm their occurrence, but to no avail. Our excitement was further dampened by the rain and we had to return without seeing the birds.

The next visit was on 6 October 1992. We were keen to see the bird and so concentrated our efforts on the area where we had heard *P. xantholaemus*. Our strategies yielded good dividends and as in the first visit to the area, we heard the birds. Within few minutes a pair of *P. xantholaemus* emerged out of the *Ficus*, when we had a good look at the birds and confirmed their identity. From the *Ficus*, the birds flew up to the small bushy trees on the vertical rock face and were seen catching some insects. Later they flew across on to the other side of the hill and we lost sight of them. A flock of three Redvented Bulbuls *P. cafer* and Redwhiskered Bulbuls *P. jocosus* were seen foraging in the vicinity.

The habitat where *P. xantholaemus* was sighted had dense vegetation comprising of a few trees of *Citrus maxima* along with *Ricinis, Schefflera, Sterculia, Acacia coccinea,* and *Lantana* which formed the edge of an old plantation.

Our sighting of *P. xantholaemus* happens to be the first report of the species for this area. Although the entire B.R. hills range was surveyed by the late Salim Ali during his survey of erstwhile Mysore state (Ali 1942, *JBNHS* 43, 44), he did not come across the species. Even R.C. Morris (1894-1977) an avid sportsman-naturalist, who spent most of his active life in B.R. hills range (Honnamatti Estate), failed to come across the bird.

P. xantholaemus has seemingly a disjunct but a wider distribution than hitherto accepted.

June 12, 1993

S. KARTHIKEYAN
24, Opp. Banashankari Temple, Shakambarinagar,
8th Block Jayanagar P.O., Bangalore 560 082.
J.N. PRASAD
T.S. SRINIVASA
C/o Merlin Nature Club, 13, 8th Cross, 30th Main,
J.P. Nagar I Phase, Bangalore 560 078.

21. A NOTE ON BAYA, *PLOCEUS PHILIPPINUS* NESTING ON KRISHNACHUDA (*DELONIX REGIA*) TREE

During my tours, during August 1990 while I was at Haflong (Assam, c. 25° N, 93° E), I came across a krishnachuda tree (*Delonix regia*) on which a large number of Indian baya were nesting. The tree was standing within the compound of a house. Moreover, there was a small Assam type building around the stem of the tree. The tree was on Garampani-Diyungbra road and about 7 km from Diyungbra.

I had never seen Indian Baya nesting on krishnachuda and that too within a compound of a house.

As I knew the nearest colony site of Baya on a betelnut grove about 20 km away on Diyungbra-Lanka road, I went there and found that the betelnut grove had been felled and cleared. A few Bayas had constructed nests on a lone betelnut palm. A few others on a phoenix palm. There were some nests on a Sirish (*Albizzia* spp.).

Except the *Albizzia*, all other trees were standing within compounds. The number of nests on the krishnachuda tree were more than a thousand.

September 6, 1993

K.K. GUPTA

40 A, Central road,

Calcutta 700 032.

22. THE MYSTERY OF "MASS SUICIDES" BY BIRDS

The ornithological catastrophes at Jatinga, Haflong and other remote areas of Assam have been known as far back as I can remember, though the first written record of the mass suicide of birds I can trace is by Salim Ali (1962) when he made a trip to the area with E.P. Gee. This was as a preliminary examination of possible sites for the capture and ringing of migratory birds. The same trip is referred to by Gee in his chapter on the Bird Mystery of Haflong in the WILDLIFE OF INDIA (1964) and to another place in the Cachar Hills by Rao and Zoranthanga (1979).

All required identical atmospheric conditions:

1. Dark nights, overcast with fog or mist and a little drizzle.
2. Gee added the additional information that the light at which they were caught had to be round and circular and not beamed like the light from an electric torch or the headlights of a car and the remains of birds which had been killed or caught were all of species resident in the area.

Then Sunjoy Monga and U. Rane (1986) visited the recently established holiday camp at Malshej Ghat on the edge of the Western Ghats with a party from BNHS and found a lot of resident birds hitting the eastern side of the bungalow and killing themselves by breaking their necks, legs or wings and allowing themselves to be captured by the locals for being eaten or for sale.

Except for a newspaper report by Chandrakant Dixit (1984) of a trip by Dr. Sengupta of the Zoological Survey of India, Monga was also the first observer to visit such a place when so many birds were killing themselves. He referred to a high wind and was able to obtain dead or wounded birds some of which were brought to Bombay for identification. The places in Assam had been visited by the observers some time after the birds had killed themselves. There was much guess-work, but all along there appeared to be little doubt that though Salim Ali was still considering the capture and ringing of birds under these circumstances he had no evidence of any migrants being caught under these conditions. Though ducks and geese were seen at Haflong a little later, these were not birds getting captured at lights and there is reference only to flights high up in the sky going south. While writing of the same place after a joint trip with Salim Ali (Gee 1964) refers to birds going north. There seems to be little doubt that the movements are local and have nothing to do with migration on a large scale as has been believed all along.

All the birds captured both in Assam and Malshej were locally resident birds which must have moved short distances and the new factor of a high wind suggested cyclonic conditions further supported by the deep, long valley on one side and the high pinnacles on the other. Lavkumar Khacher (1978) refers to a teal so captured no doubt being forced down by the wind. Sunjoy Monga has drawn attention to several species obtained at Malshej which have been listed as Migrants and obtained apparently in breeding condition. The clause on my Checklist (1981) which states that the term migrant relates to the Konkan appears to have been overlooked, and it is possible that some of them nest east of the Ghats in the Deccan.

I also visited Malshej Ghat the same year (1984) with Sunjoy Monga and there is little doubt that a high wind was blowing for as we drove up the ghat road and were nearing the top, a stream which flowed down the side of hill and passed under the road was lifted off its bed and flung across the road on to the top of the car!

We have read or heard of hundreds or thousands of birds meeting their end at Jatinga, Haflong. It is difficult to imagine what area was covered by this wind but the number of birds was certainly very large.

After my return to Bombay I have been turning over the whole matter in my mind but have not been able to decide on anything definite to put on record. Some time back however I mentioned this matter to Wg. Cdr. Qaiser Ali, who had recently retired from Air India. He mentioned that it was a well-known fact that all winds approaching a storm or whirlwind in the northern hemisphere, when given the right physical conditions blew in an anti-clock-wise direction. The evidence from Malshej Ghat showed when the wind got to the edge of the Ghat, it behaved in this manner and the birds carried by it would make for the nearest lights which would be the only indication of safety to doves, quails, rails, and other ground loving birds. These would, if and when they missed the light and got swept beyond the edge of the Ghat, would redouble on their tracks and hit the lights from the opposite direction.

This seem to be a simple explanation of a mystery made more mysterious by planning from afar.

February 9, 1994

HUMAYUN ABDULALI
3, Reshma Apartments,
13, Pali Hill, Bandra,
Bombay 400 050.

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23. COLOUR CHANGE OF TONGUE BY FAT-TAILED GECKO *EUBLEPHARIS MACULARIUS*

On 31 January 1994, while digging stones in Kamalnath Forest Block in Udaipur District for making a rubble masonry wall around a plantation, labourers noticed a strange animal under a stone. I was informed and I identified it as the Fat-Tailed Gecko *Eublepharis macularius*. It was a subadult individual, still possessing the characteristic coloration of an immature individual.

When I forced it to leave its hideout, it raised its body on all four legs and opened its mouth widely. I could see its tongue easily. Initially its colour was pinkish-white but soon its distal portion became deep-pink. The lower portion of its tongue remained normal, i.e. there was no change in colour. I caught hold of the animal in my hands and observed the phenomenon carefully. The colour disappeared and re-appeared many times within five minutes.

This coloration may have been due to increased blood flow to the tongue tip. Perhaps this colour change of the tip of the tongue is a threatening posture of the animal.

October 4, 1994

SATISH KUMAR SHARMA
Range Forest Officer,
Aravalli Afforestation Project,
Jhadol (F.), Dist. Udaipur 313 702,
Rajasthan.

24. PRESENCE OF COMMON GREEN WHIP SNAKE *AHAETULLA NASUTUS* AT "PHULWARI KI NAL" WILDLIFE SANCTUARY IN RAJASTHAN

On November 4, 1993, while wandering in Dharawan Reserve Forest of "Phulwari Ki Nal" Wildlife Sanctuary in Udaipur District, I bagged a common green whip snake *Ahaetulla nasutus* from a clump of *Dendrocalamus strictus* with the help of labourers working there. The Dharawan forest is a hilly area having luxuriant growth of *Dendrocalamus strictus, Wrightia tinctoria, Lannea coromandelica, Boswellia serrata, Butea monosperma, Sterculia urens, Emblica officinalis,* etc.

Measurements of the snake are : Total length: 1470 mm; Vent to tail-tip length: 535 mm; Weight: 67 gm; Ventrals: 197; Subcaudals: 157.

According to Daniel (1983, THE BOOK OF INDIAN REPTILES), this species is distributed in peninsular India excluding the Ganges valley, west of Patna, eastwards to Burma and Sri Lanka. It is thus worth noting that this snake is present in the southern part of Rajasthan State.

September, 6 1994

SATISH KUMAR SHARMA
Range Forest Officer,
Aravalli Afforestation Project,
Jhadol (F.), Dist. Udaipur 313 702,
Rajasthan.

25. A NEW ALTITUDINAL AND RANGE RECORD FOR THE COPPER FLASH BUTTERFLY *RAPALA PHERETIMUS* HEWITSON (LYCAENIDAE)

The butterfly *Rapala pheretimus* Hewitson (Lepidoptera: Lycaenidae) has been recorded east of Sikkim (Evans 1932, Wynter-Blyth 1957) to Malaya, Sumatra and Borneo (Lewis 1973). Bailey (1951) observes that he obtained a few in the (Kathmandu) Valley, between June and October; Devighat 1,500 feet (450 m) 25 October 1935 and a specimen brought in from the north (of Kathmandu) Dendrawati, 18 May 1935.

Thirteen specimens (12 males, 1 female, FW expanse 1.7 to 1.9 cm) were taken between April 21, 1994 and April 30, 1994 in the Bhimtal valley in Nainital District, Kumaon, U.P. at an elevation of *c.* 1500 m and two males were taken near Kaladhungi in the same district at an elevation of *c.* 500 m on May 2, 1994.

This represents a westward extension of approximately 500 km to the known range of this butterfly.

Hannyngton (1910) did not obtain this butterfly in Kumaon, although he collected in the same area and during the same season. Besides, my late father, Fred Smetacek Sr., who collected butterflies in this area for over thirty years from 1949, did not record this butterfly.

This group of butterflies is not known to migrate. It therefore seems that the specimens taken belong to a recently established colony in Bhimtal and in Kaladhungi.

These butterflies are fond of flowers, particularly of edible Chestnut (*Castanea* sp.), which they visit during the morning hours. Several males and the female were taken at these trees. The remaining males were taken basking on prominent leaves up to 10 m above the ground and patrolling their "beats" in the afternoon hours. The specimens from near Kaladhungi were taken in a damp nullah in shady sal (*Shorea robusta*) forest, where others were seen sitting briefly on the tops of bushes and saplings in the shade, but not taking up beats.

Of the above specimens, thirteen are in the collection of the National Museum of Natural History in New Delhi. The remainder are in the author's collection.

December 6, 1994

PETER SMETACEK
Jones Estate,
P.O. Bhimtal, Nainital,
U.P. 263 136.

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26. NEW RECORD OF A CONCHOSTRACAN (CRUSTACEA: BRANCHIOPODA) FROM MAHARASHTRA STATE

During the survey of water bodies of Pune area, two hitherto unnoticed, interesting crustacean specimens were obtained on 26th July, 1993 in a small temporary rainwater pool on Kirkee road, behind the University of Poona. There is a more or less permanent water body in the form of an old stone quarry nearby. Examination of these specimens revealed that they belong to subclass Conchostraca (the so called clam shrimps) and the species turned out to be *Leptestheriella maduraensis* Nayar and Nair.

Perusal of the available literature showed that there is no record of this species from Pune District and even Maharashtra State.

The species *L. maduraensis* was first described by Nayar and Nair on the basis of specimens collected from a quarry pool at Narasingapatti near Madurai, Tamil Nadu, in November 1965. The description given by Nayar and Nair (1968) agrees well with our specimens but the length is slightly more, telson is narrow with 34 unequal spines and furcal claw has 20 spines. The other closely related species is *L. inermis* Bernard, from which *L. maduraensis* can be distinguished by the presence of spines and setae on the dorsal armature of the body segments. Both the specimens are deposited in WRS, ZSI, Pune.

We are grateful to the authorities of Modern college, Pune, Director, Zoological Survey of India, Calcutta and Officer-In-Charge, Western Regional Station, Zoological Survey of India, Pune, for permission to carry out this work.

September 2, 1994

H.V. GHATE
Department of Zoology,
Modern College, Pune 411 005.
S.G. PATIL
Western Regional Station,
Zoological Survey of India,
Pune 411 004.

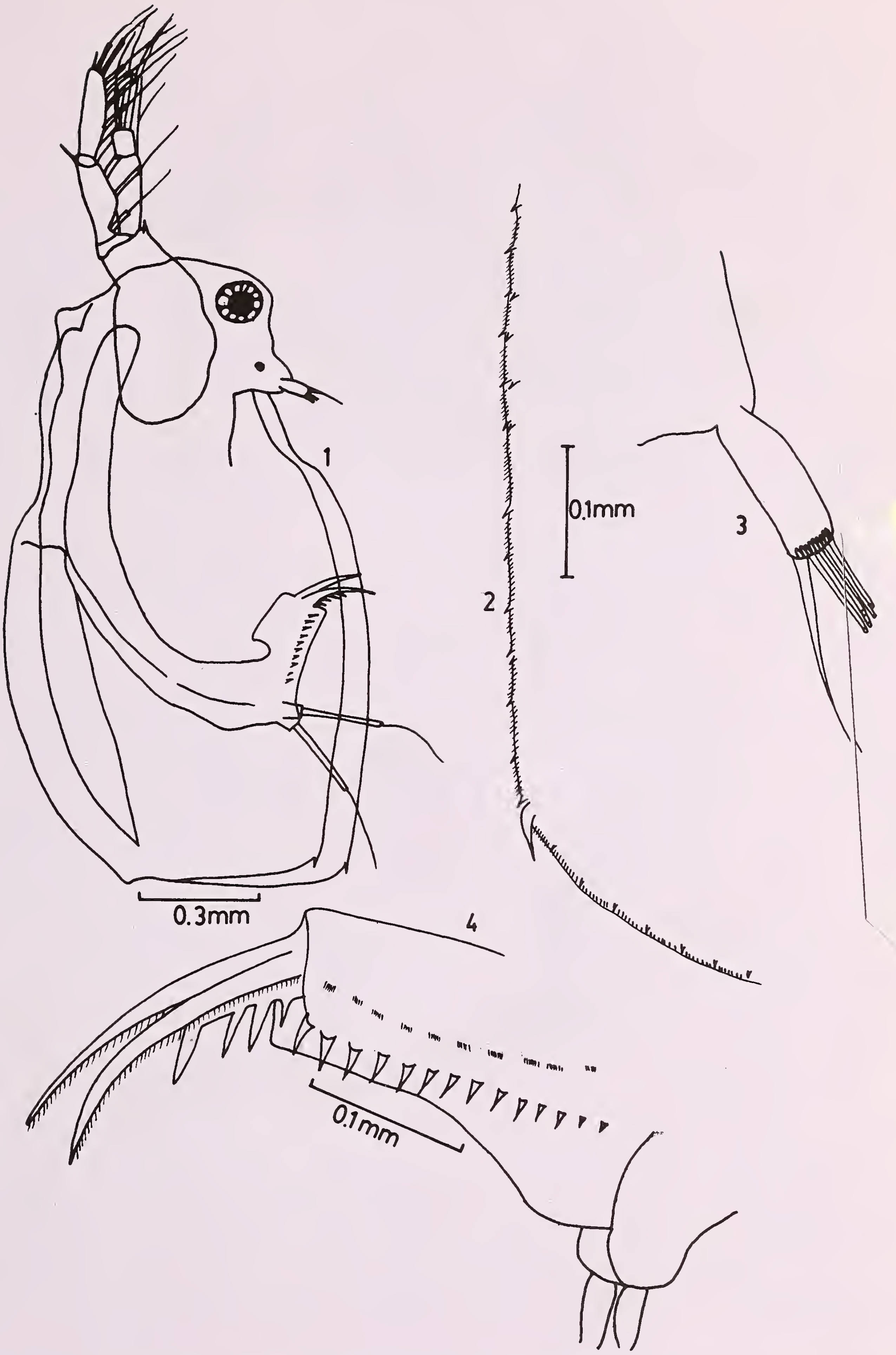
REFERENCE

NAYAR, C.G.K. & K.K.N. NAIR (1968): On a collection of Conchostraca (Crustacea: Branchiopoda) from South India, with the description of two new species. *Hydrobiologia: Acta Hydrobiologica Hydrographica et Protistologica, 32:* 219-224.

27. ON *SIDA CRYSTALLINA* (O.F. MULLER, 1776) AND *ACROPERUS HARPAE* (BAIRD, 1834) (CRUSTACEA: CLADOCERA) FROM TRIPURA STATE

(*With eight text-figures*)

The survey of the wetlands of Tripura yielded two new cladoceran records, *Sida crystallina* (O.F. Muller, 1776) of the family Sididae and *Acroperus harpae* (Baird, 1834) of the family Chydoridae. Both the species were first recorded in India from Kashmir by Brehm (1936) and then from Assam and Shillong


1
0.3mm
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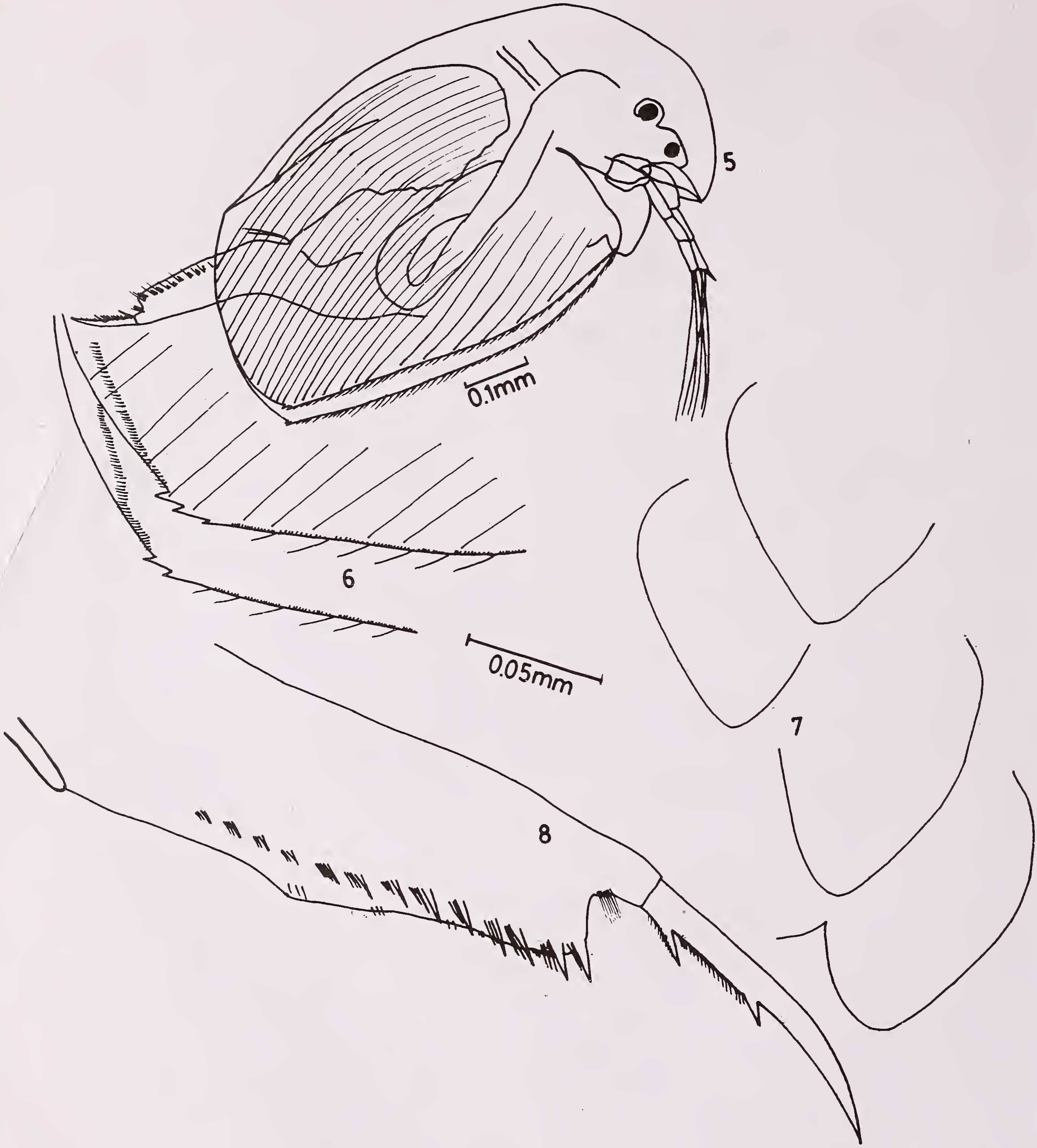
Figs. 1-4. *Sida crystallina* (O.F. Muller) - female: 1. Lateral view; 2. Postero-ventral corner; 3. Antennule; 4. Postabdomen.



Figs. 5-8. *Acroperus harpae* (Baird) - female: 5. Lateral view; 6. Postero-ventral corner; 7. Labrum; 8. Postabdomen.

by Biswas (1980) and Michael and Sharma (1988) respectively. They are also recorded from China (Sieh-Chih and Nan-Shan 1979). However, *S. crystallina* is not found in the tropical regions of South Asia and South-East Asia. In the present study, the diagnostic characters of both the species are described.

Family: SIDIDAE Baird, 1850
Genus: *Sida* Straus, 1820

1. Sida crystallina (O.F. Muller, 1776)

(Figs. 1-4)

Material examined: Lake No. 1 and Ricefield marsh of Trishna Wildlife Sanctuary and Sepayjala Wildlife Sanctuary, Agartala.

FEMALE: Body size 1.50 mm. Body cylindrical and oblong. Head large, with rostrum and ocellus. Cervical depression present. Eye small, situated in the ventral region of the head (Fig. 1). Ventral margin of carapace with setae and setules arranged alternately ending with a large denticle at the postero-ventral corner (Fig. 2). Antennules short, truncate with short flagellum (Fig. 3). Antenna robust with setae 0-3-7/1-4. Postabdomen narrow anteriorly with 14 lateral spines and lateral setae above. Claw with four basal spines with a row of setae (Fig. 4).

Remarks: The body size of *S. crystallina* recorded in the present study is 1.5 mm. The same species was recorded in China with a body size of 2.2-3.5 mm (Sieh-Chih and Nan-Shan 1979). However, Michael and Sharma (1988) reported *S. crystallina* from Assam with a body size of only 0.68 mm. Adult females often vary in size in different populations due to varying environmental conditions. However, the size of the specimen recorded from Assam by Michael and Sharma (1988) is rather unusual and the size variation is very large.

Family: CHYDORIDAE Stebbing, 1902
Genus: *Acroperus* Baird, 1843 emend, Smirnov, 1966.

2. Acroperus harpae Baird, 1834

(Figs. 5-8)

Material examined: Gumti Reservoir, Jatanbari, Gumti.

FEMALE: Body size 0.62 mm. Body evenly rounded dorsally, head keel present, maximum height in the middle (Fig. 5). Posterior margin convex and slightly shorter than maximum height of body. Valves with distinct longitudinal lines, ventral margin with a series of setae and groups of fine setules between the setae. Postero-ventral corner of the valves with 2-3 denticles followed by a series of setules along the posterior margin (Fig. 6). Rostrum blunt, antennules not reaching apex of rostrum. Ocellus small and situated closer to the eye than to the apex of rostrum. Labral plate with rounded anterior margin (Fig. 7). Postabdomen long with very small spines and 13-15 groups of lateral setae which decrease in size proximally, distalmost seta being the largest and stoutest of each group and in the six distal groups it projects beyond the dorsal margin. Claw long and slightly curved dorsally, ventral surface with two groups of setules; those in proximal group slightly larger and ending with a spine-like setule in the middle, distal group consists of short setules ending some distance before the tip. Basal spine short with spinules at the base (Fig. 8).

Remarks: In the present study, *A. harpae* shows some variation in the shape of the labral plate from other descriptions such as by Michael and Sharma (1988) from India, Idris (1983) from Malaysia and Smirnov (1974) from USSR. The character that differentiates *A. harpae* from *A. angustatus* is the maximum height of the body which is more than 64% in the case of former and 56% in the latter. Smirnov (1974) found that this character varies at different stages of life. More studies are required to ascertain the validity of these species, since both the species have been recorded from the same locality in the present study.

September 25, 1993

K. VENKATARAMAN
S.R. DAS
Zoological Survey of India,
New Alipore, Calcutta 700 053.

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28. REDESCRIPTION OF *PHRYNICHUS PHIPSONI* POCOCK (FAMILY PHRYNICHIDAE: ARACHNIDA) COLLECTED AFTER 100 YEARS FROM NEW LOCATIONS IN MAHARASHTRA, WESTERN INDIA

(*With fourteen text-figures*)

Amblypygids are uncommon arachnids, with secretive habits and habitats. They generally occur in humid forest areas and rarely encroach human habitations. However, Gravely (1915) states "one species *Phrynichus lunatus* Poc. is not uncommonly met with in Bungalows in Sri Lanka". They are also known as scorpion-spiders because of the pedipalps appear as in scorpions. They look more like spiders and females carry their eggs in cocoons, attached to the ventral side of their body. So far there are six to seven named species of four oriental genera under two distinct families, namely Phrynichidae with broad cephalothoracic sternal plates and tarsus of the legs without pulvillus (Fig. 11). Whereas the second family Charontidae possess smaller cephalothoracic sternal plates and the three posterior tarsus of legs possess a prominent pulvillus. First leg is modified, anteniform and exceptionally long (Fig. 1).

Amplypygids are not authentically reported from India after Pocock 1894. The only known species are *Phrynichus phipsoni* Poc. (Family: Phrynichidae/Loc: Trivandrum, Kerala and Bombay, Maharashtra) and *Sarax sarawakensis* Thorell (Family: Charontidae/Loc: Table Island, Andaman, and also Singapore, Borneo, New-Guinea and Soloman Island). The specimens from Andaman were captured beneath stones at low water on the coast of Table Island, at all other places specimens were found in caves.

Recently, I collected three specimens from two different places in Western Ghats of district Sindhudurg, Maharashtra, i.e. Phonda and Amboli ghats. These localities are about 600 to 800 km south of Bombay from where the earlier distribution and records are available (Pocock 1900). The fresh specimens were collected from under large stones at about 850 m elevation in totally wet soil. A single specimen collected from Borivli National Park, Bombay (donated to Arthropod Museum, Pune) happens to be the second record since Fauna of British India (1900). The third and most recent record is made from North Arcot district of Tamil Nadu (pers. comm. 1993, by Dr. (Mrs) T.J. Indra, Zoological Survey of India, S.R.S., Madras). The specimens collected from Sindhudurg district are redescribed and illustrated to update the description and illustrations for easy identification.

Phrynichus phipsoni Pocock
(Figs. 1-4)

1894. *Phrynichus phipsoni* Pocock. *Arn. Mas. Nat. Hist.,* 14 (6): 295.

1900. *Phrynichus phipsoni* Pocock. *Fauna Brit. India, Arachnida:* 127.

General: Body large to medium size, prominent with pseudo-pedipalps and the anteniform 1st pair of legs, much flat; cephalothorax truncated on anterior margin, wider than long, with two sets of outer tubercles, abdomen superficially segmented into 12 segments, last segment covers anal aperture. Coxae of 1st leg not visible ventrally, coxae of 3rd and 4th legs separated (Fig. 2), 2nd sternite possesses semicircular genital lobes (Fig. 14).

Measurements: ♀ Total length 22.50 mm, cephalothorax 7.50 mm long, 13.50 mm wide, abdomen 15.00 mm long.

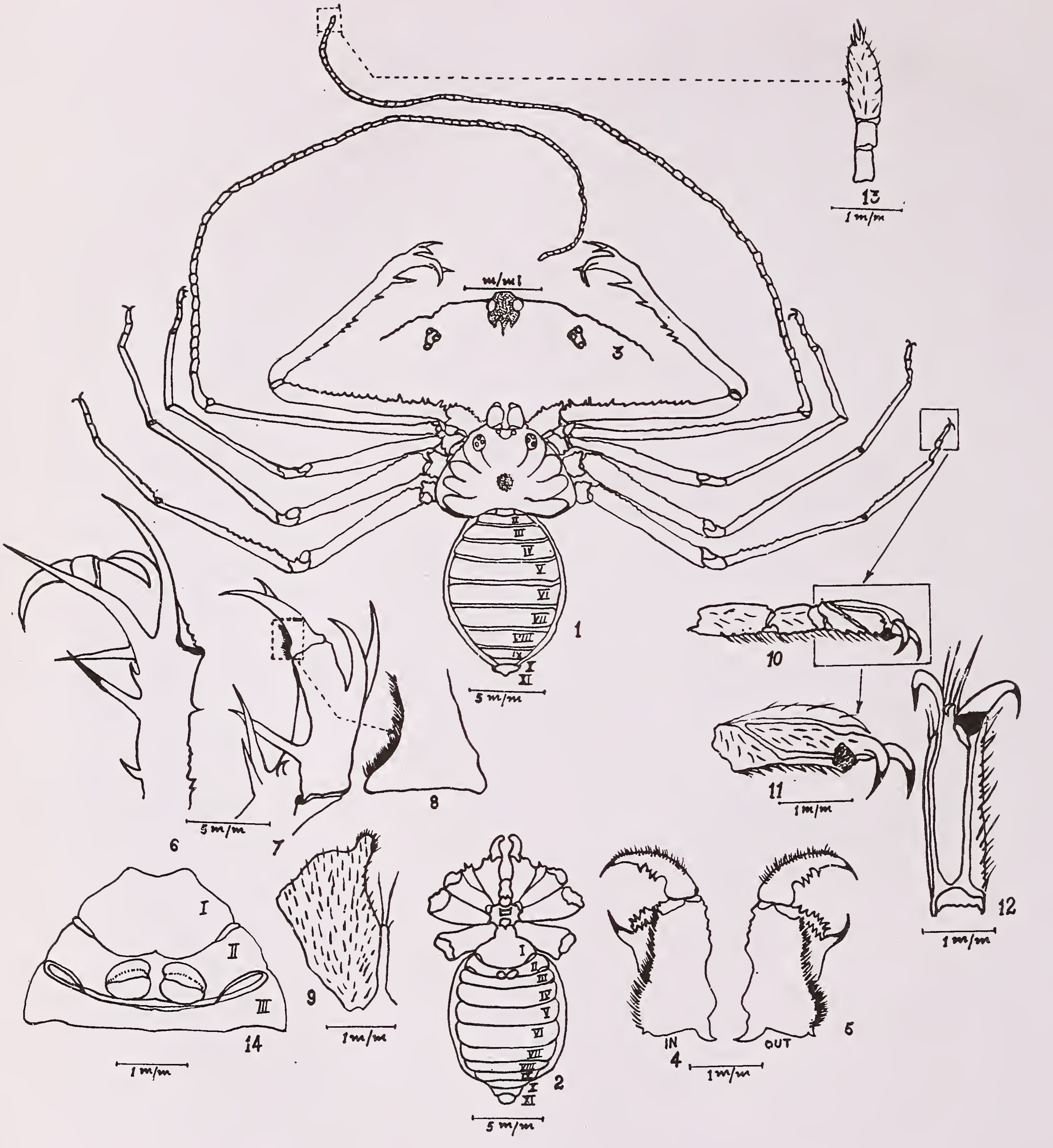
Carapace (Cephalothorax): Always wider than long with truncated anterior margin. Median posterior portion slightly raised and centrally deepened into a elongated central notch (Fig. 1). Entire surface rarely granular otherwise smooth with regular darker radiating stripes (Fig. 1). Median ocular tubercles almost on the sub-anterior margin, slightly raised, smooth and provided with a pair of median eyes (Fig. 3). A pair of lateral ocular tubercles situated on anterior lateral corner of carapace, smooth, slightly raised and provided with three pairs of eyes, smaller in size than median eyes (Fig. 3). Anterior, lateral and posterior margins smooth. Cephalothoracic sternum broad, superficially segmented into four parts (Fig. 2), continued anteriorly into thin elongated, tongue like process provided with a pair of long bristles (Fig. 9). Coxae of pedipalps and legs arranged radially round the sternum (Fig. 2). Pedipalp coxae broad, covered with short bristles, provided with 6-9 sharply pointed bristles arranged on inner margin, proximal to tubercle, bluntly tuberculate on anterior inner margin, armed with thick, short bristles on anterior margin while few longer bristles on outside, probably assisting while feeding (Fig. 9). Coxae of 1st pair of legs narrowed and raised under carapace, not easily marked ventrally. Coxae of 2nd to 4th pair of legs, broad and 3rd and 4th pairs widely separated (Fig. 2).

Chelicerae: Primitive, two segmented, semichelate, movable finger vertically operative, basal segment compressed laterally, surface smooth, clothed with a fringe of small, short, delicate bristles and hair (Figs. 4 & 5), clustered with many short, blunt to sharp group of teeth on ventral distal portion with single ventral large tooth (Figs. 4 & 5), movable finger almost ¾ the basal segment, sharply pointed distally, armed with four to five minute sharp teeth on interior margin (Figs. 4& 5).

Pedipalps: Prehensile, subchelate, moving in horizontal plane, six segmented; trochanters as long as half the carapacial length, smooth, armed with short tubercles on exterior surface. Femur four and a half times as long as trochanter or twice as long as carapace, slender armed with many spiniform tubercles on exterior surface. Tibiae almost as long as femur, few short spines on proximal portion both on outer and inner surface but strongly spined on distal end, ending into two apical spines (Fig. 6), one subapical spine, as long as half the apicals and one small, anteriorly curved, small spine in between inner apical and a subapical (Fig. 6). Hand, more flat than preceding segments, almost one third in length of either femora or tibiae or slightly less than half the carapacial length; armed with two strong spines one on each lateral surfaces (Fig. 7). Finger, the last segment, clawed, spined strongly, sharply pointed, shorter than hand but always longer than any of the spines on tibiae and hands, the proximal inner margin provided with a fringe of delicate, short bristles at the base only (Figs. 7 & 8).

Legs: Four pairs of legs, 1st pair always modified and anteniform, trochanters small, femora elongated, almost three times as long as carapace, thin, anterior or exterior margin minutely crenulated and entire surface covered with minute but obsolete sparsely spread granules, patellae one sixth of femora, tibiae modified and segmented into 29-30 small segments, tarsi also elongated, modified and subdivided into almost 20-25 small digits, apically ending into a elongated bulbous segment, apical tip provided with a pair of minute, delicate claw (Fig. 13), this perhaps helps as a tactile organ. Legs 2-4: with short trochanters, elongated femora and tibiae, entire surface covered with obsolete, sparsely spread granules but short patella, tarsi four segmented, and each provided with a distal claw (Figs. 10-12). The last digit of tarsi provided with some dorsal and lateral elongated sutures (figs. 10-12), proximal, elongated, tarsal digit provided below with a paired row of delicate but strong spines, three distal tarsal digits provided below with a row of delicate and minute spicules (Fig. 11). Pulvilli shrunk to a dark membranous structure (Fig. 11).

Abdomen: Oval, superficially segmented into 12 terga on dorsal and 11 sterna as ventral, all smooth, last one or two tergites form a flap on anal aperture (Figs. 1 & 2). First sternite enlarged, broad, narrowed anteriorly, 2nd and 3rd sternites provided each with a pair of lateral pulmonary apertures (Fig. 14), and a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5

Figs. 1-14. 1. Dorsal view of female *Phrynichus phipsoni* Pocock; 2. Ventral view of body, appendages omitted; 3. Dorsal view of anterior portion of carapace showing median and lateral eyes; 4. Lateral inner view of chelicera; 5. Lateral outer view of chelicera; 6. Dorsal view of anterior portion of pedipalp; 7. Ventral view of same; 8. Enlarged view of ventral proximal portion of finger; 9. Ventral view of pedipalp coxa and anterior portion of cephalothoracic sternum; 10. Lateral view of distal tarsal portion with claw; 11. Lateral view of last tarsal segment showing claw, pulvillus shrunken to black patch and delicate elongated sutures; 12. Dorsal view of last tarsal segment showing delicate sutures; 13. Dorsal view of distal tarsal portion of 1st leg; 14. Ventral view of abdominal sternites 1-3 showing lateral pulmonary apertures and a pair of genital lobes on sternite 3.

pair of semicircular lobes representing genital lobes on middle portion of 2nd sternite, open between 2nd and 3rd (Fig. 14).

Collection Data: 1. Loc: 30 km west of Amboli, in Amboli ghat, 820 m elevation, under large boulder and wet mud, dt. 19-9-1987, coll. Dr. D.B. Bastawade & party. 1 ♀ mature, 1 ♀ immature.

2. Loc: 18 km west of Radhanagari, in Phonda ghat, about 800 m elevation, under large boulder along the roadside, dt. 10-9-1987, coll. Dr. D.B. Bastawade & party. 1 ♀ immature.

August 31, 1994

D.B. BASTAWADE
Zoological Survey of India,
Freshwater Biological Station,
10-1-300/B, Ashoknagar,
Hyderabad 500 020.

REFERENCE

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29. *SIPHONODON CELASTRINEUS* GRIFF. (SIPHONODONTACEAE) - A RARE TREE FROM ORISSA

Siphonodon celastrineus Griff. (Siphonodontaceae), an interesting tree occurs in Similipahar forests (Mayurbhanj district) of Orissa. Haines (Forest Flora of Chotanagpur, 1908 and Botany of Bihar and Orissa, 1921-1925) reported this species from Rajmahal hills of Bihar, but from Orissa this taxon has never been collected before. The species is known to occur sporadically in parts of Eastern India, Andamans, Sikkim, Bhutan, Myanmar, Philippines, Java and Thailand.

In the present collection from Gurguria, Simlipahar (*Saxena & Brahmam* 4723, 5182 -RRL-B, in fruit 12-6-1982 and 19-10-1983), a population of only a few trees was noticed. The species can well be classified as Endangered in the status categories of IUCN's Red Data Book (1966).

February 12, 1994

M. BRAHMAM
H.O. SAXENA
Regional Research Laboratory,
Bhubaneshwar 751 013,
Orissa.

30. *ERYNGIUM FOETIDUM* LINN. (APIACEAE) - A NEW RECORD FOR BIHAR

The genus *Eryngium* Linn. with about 230 species (Mabberley 1987) is represented by 3 species in India, two are indigenous and confined between 1,650 m - 1,680 m in north western Himalayas, the third *E. foetidum* Linn. is a native of tropical America, now naturalised in some parts of India (Babu 1977). We recently collected *Eryngium foetidum* Linn. from Bhagalpur District of Bihar. Perusal of literature (Brassers 1951, Haines 1961 (Repr. ed.), Hooker 1879, Mooney 1950, Sinha 1987, Srivastawa 1964, Srivastawa 1986, Varma 1981) revealed that this taxon has not been reported earlier from any part of Bihar. The present note includes our observations on its morphology, phenology, ecology, distribution and uses. The specimen cited is deposited in Bhagalpur University Herbarium and also introduced in the Botanical garden.

Eryngium foetidum Linn. Sp. Pl. 232. 1753; Burkill in Rec. Bot. Surv. Ind 10: 291. 1924.

Fl. & Fr.: March-July.

Locality: Dholbazza, a village situated about 30 km north of Bhagalpur town across the river Ganga (Bhagalpur District), Bihar.

Specimens examined: Dholbazza, N.N. Das 4300.

Ecology: In shaded alluvial soil near human habitation.

Distribution: Native of tropical America, introduced in some parts of tropical Africa and Asia; in Malaysia: Malay peninsula, Sumatra, Java; Nepal and in India: Assam, Arunachal Pradesh, Manipur, Madhya Pradesh, West Bengal, Kerala, Uttar Pradesh and now Bihar (Bhagalpur District).

Uses: Locally, like *Coriander* leaves the green leaves are used for flavouring food articles.

December 2, 1993

S.K. VARMA
N.N. DAS
University Department of Botany,
Tilka Manjhi Bhagalpur University,
Bhagalpur 812 007,
Bihar.

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31. *PASCALIA* ORTEG. (ASTERACEAE) - A NEW GENUS FOR INDIA

(*With a text-figure*)

The monotypic genus *Pascalia* Orteg. is represented by *P. glauca* Orteg. of the family Asteraceae. The species was known so far only from Chile, South America. During the course of identification of the specimens received from the Assistant Director of Animal Husbandry, Animal Disease Intelligence Unit, Coimbatore, Tamil Nadu, we came across some interesting specimens. Detailed study of the vegetative as well as floral characters of the plant revealed its distinctness from all known Indian Compositae genera. Consequently the plant was identified as *Pascalia glauca* Orteg.

As none of the Indian Floras, past or present, dealt with this monotypic genus, the present paper records the genus as new for India.

This species is hitherto not recorded from India and its rare occurrence probably suggests that it is a very recent introduction to this part of the world and possibly through food grains. This weed is now naturalised in a particular area of Coimbatore.

According to Animal Disease Intelligence Unit of Animal Husbandry, Coimbatore, the plant has a poisonous effect on grazing cattle and in cows the foetus gets aborted a few hours after consumption. It seems that the symptoms are somewhat like hydrocyanic acid poisoning.

As the species is new to Indian Flora, a detailed description along with a photograph is presented here for easy identification, especially to Botanists and Veterinarians.

Pascalia glauca Orteg. Hort. Matr. Dec. 39. t. 4. 1797.
(Fig. 1)

Annual or perennial herbs. Stem erect with longitudinal striations, glabrous or minutely scabrous. Leaves simple, opposite, distichous, rarely alternate towards apex, lanceolate, oblong-lanceolate or narrowly obovate, base narrow, apex acuminate, generally 1-2 dentate, sometimes more in the lower,

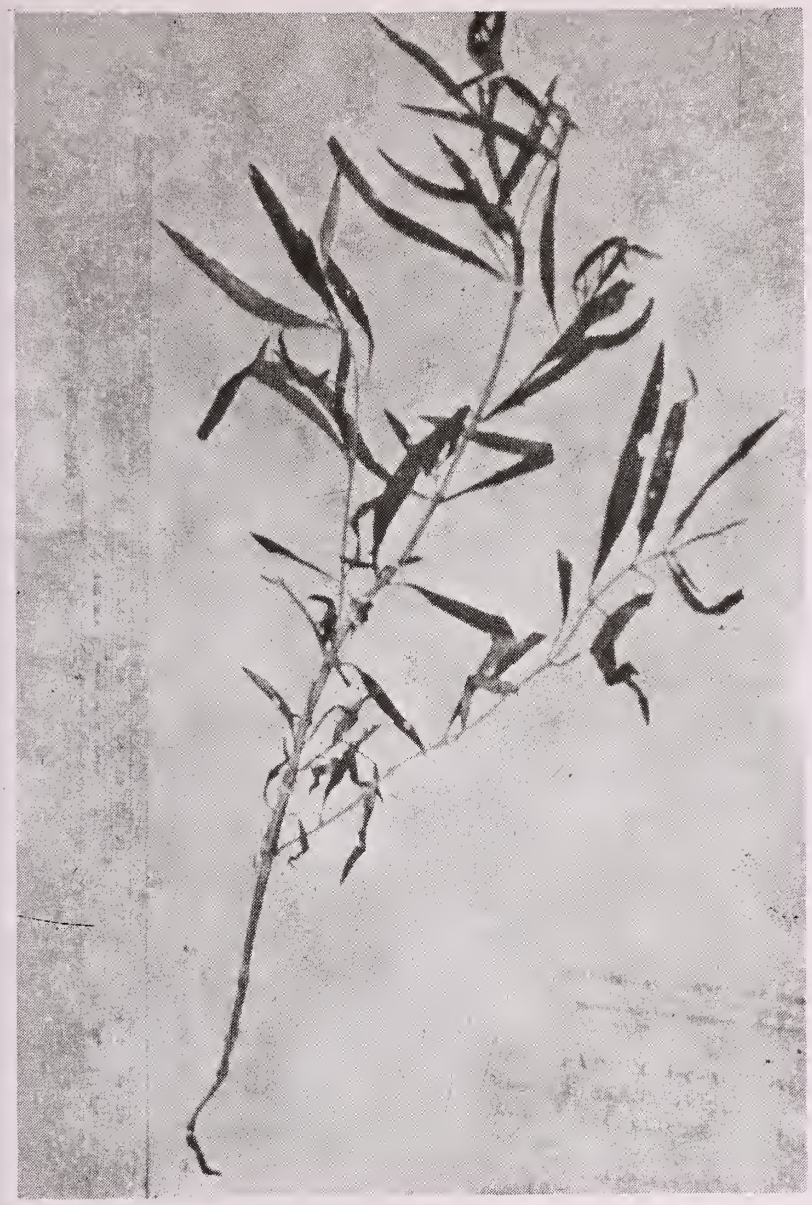

Fig. 1. Habit of *Pascalia glauca* Orteg.

thinly appressed, strigose hairs on both the surfaces, 4-5 x 0.8-1.2 cm. Heads solitary in the leaf axils, 1-1.5 cm in diameter, heterogamous, radiate. Disc flowers hermaphrodite, fertile; involucre hemispherical; peduncles 1.5-2 cm long, hairy; bracts almost 2-seriate, outer linear, shortly acuminate, acute or rounded at the apex, 1-1.5 mm long, inner one lanceolate, acuminate, 0.8-1 mm long, membranous. Receptacle sub-plain; palea membranous, folded; pales oblong lanceolate, very acute, 5-6 mm long. Flowers bisexual; corolla yellow, ligulate in the female flowers, widely spreading, 8-11 mm long with a very short tube, limb elongate, cylindrical, apex 5-fid, ligule short, 2-3 dentate, anthers with truncate base and acute apex, entire, exserted. Style branched in appendix, slightly acute, terminally hairy. Achenes obovoid, more or less compressed, cuneate, rugulose or glabrous, 4-5 mm long, ray flattened above. Disc tetragonal, laterally compressed, thick altogether. Pappus minutely scaly, short.

Flowering and Fruiting: September to February.

Specimen examined: Tiruppur, Coimbatore, 1-1-1987, *M.S. Deesigah s. n.* (CAL).

ACKNOWLEDGEMENTS

We are grateful to the Assistant Director of Animal Husbandry, Animal Disease Intelligence Unit, Coimbatore, Tamil Nadu, for supply of unidentified specimens. We thank the Joint Director, Central National Herbarium, for giving herbarium consultation facilities.

February 12, 1994

ALOKE BHATTACHARYA
M.C. BISWAS
H.S. DEBNATH
Central National Herbarium,
Botanical Survey of India,
Botanical Garden,
Howrah 711 103.

32. ON THE IDENTITY OF *PARABOA NAGALANDIANA* DEB & DUTTA

Paraboa nagalandiana Deb and Dutta (1988) was proposed on the basis of two gatherings: *A. Meebold* 7394 & 7230, collected from Nagaland in Dec. 1907. These were named as *Spiradiclis bifida* Wall. (Rubiaceae) and placed in the herbarium accordingly, which were separated in course of a taxonomic study of the genus *Spiradiclis* (Deb and Rout 1989).

On describing, it was presumed to represent either Gesneriaceae or Acanthaceae. From the absence of cystolith on leaves and jaculators on seeds, Acanthaceae was ruled out as the subfamily Nelsonioideae possessing these characters was transferred by Bremekamp (1953, 1955) from

Acanthaceae to Scrophulariaceae. As the ovules are not inserted on a swollen oblique placenta, a very important character of Scrophulariaceae, it was not considered worthy of consideration. Thus the authors had no doubt that it belonged to Gesneriaceae.

TABLE 1

CONSPECIFICITY OF THE TAXA

	Staurogyne paniculata	*Paraboa nagalandiana*
1.	Shrubs or undershrubs branching dichotomously or unbranched, pubescent.	Undershrubs branching dichotomously or unbranched, pubescent, rooting at the base.
2.	Leaves opposite, decussate, petiolate, 15-17.5 x 3-6 cm, narrowly oblong or elliptic-obovate, acute or subacute, cuneate and slightly unequal at base, entire, coriaceous, glabrescent above, tomentose on midrib and nerves below; petiole 10-13 mm long, pubescent.	Leaves opposite, decussate, petiolate, 5-17 x 2-5 cm, narrowly oblong or elliptic-lanceolate, acute or subacute at apex, cuneate and slightly unequal at base, entire, coriaceous, glabrescent above, tomentose on midrib and nerves below; petiole 5-15 mm long, pubescent.
3.	Inflorescence terminal, racemose panicle, puberulous.	Inflorescence terminal, racemose panicle, pubescent.
4.	Flowers bracteate, bracteolate, shortly pedicelled, pubescent; bracts 1.5-2 mm long; bracteoles in pair, linear, 1-1.2 mm long.	Flowers bracteate, bracteolate, shortly pedicelled, pubescent; bracts 1-2 mm long; bracteoles in pair, linear, 0.6-1 mm long.
5.	Flower bud oblong; matured ones bilabiate.	Flower oblong; matured flower not seen.
6.	Calyx deeply divided, lobes 5, unequal, linear or linear-lanceolate, ± 5 x 2-3 mm, pubescent.	Calyx deeply divided, lobes 5, unequal, linear-lanceolate, 2-3 x 0.2-0.3 mm, pubescent.
7.	Corolla 10-13 mm long, bilabiate, pubescent, lobes 5, broad, imbricate, unequal, conspicuously veined.	Corolla examined was immature; bilabiate corolla with broad distinctly veined lobes, characteristic of *Staurogyne* was not evident; it may be that this character develops on maturity of the flower; lobes imbricate.
8.	Stamens 4, didynamous, longer pair perfect, sparsely hairy; anther lobes divaricate; shorter pair sterile.	Stamens 4, didynamous; longer pair perfect, anther lobes divaricate; shorter pair sterile.
9.	Ovary 2-loculed, axile, many ovules in each locule; style slender; stigma bilobed.	Ovary 2-loculed, axile, many ovules in each locule; not parietal as stated in the original description; stigma simple.
10.	Fruit capsule cylindrical, loculicidally dehiscent, many-seeded.	Fruit examined was immature; capsule cylindric; many seeded, dehiscence not seen.

Dr. B.L. Burtt (in lit.) in a letter dated 13 Feb. 1993 wrote that in connection with a revision of *Paraboa* in collaboration with a Chinese Botanist he read this paper and brought out *A. Meebold* 7230 from the Indian section of *Spiradiclis* extant in herb. E, and examined it closely. It appeared most probably a species of *Staurogyne* (Acanthaceae), a genus that he knows quite well because it is so often confused with Gesneriaceae (as it lacks cystoliths and jaculators), in the past. It did not match with any species in their herbarium. The corolla drawn in the figure is very short for *Staurogyne* and the fruit also differs to some extent. He named several authorities like C.B. Clarke, Handel-Mazzetti, Ridley, etc. who were experts in both the families but had also committed the mistake. He gave us references to his papers (Burtt 1958, 1960) showing names of plants from Gesneriaceae to Acanthaceae and vice versa and advised us to re-examine the specimens concerned and reidentify them.

The papers he cited are revealing. C.B. Clarke who was an authority both on Acanthaceae and Gesneriaceae described two species of *Staurogyne: S. macrantha* and *S. serculata* (Clarke 1908) which were accepted as such by Ridley (1923) until Bremekamp (1955) pointed out the mistake in his revision of the genus *Staurogyne* that these plants represent the genus *Didymocarpus* (Gesneriaceae). Handel-Mazzetti likewise described *Loxostigma sessamoides* (Gesneriaceae) erroneously, which was corrected as *Staurogyne sessamoides* (Hand.-Mazz.) B.L. Burtt (1958). *Didisandra parviflora* Ridley (1923) described in Gesneriaceae is correctly *Staurogyne bullata* Bremekamp (1953).

Burtt's letter (l.c.) was an eye opener to us. He treated *Staurogyne* in the Acanthaceae and did not follow Bremekamp (l.c.) in placing the genus in Scrophulariaceae (without assigning any reason). We looked for literature and found that Hossain (1971) on the basis of morphology, anatomy and palynological study confirmed that Nelsonoideae which includes *Staurogyne* represents the family Acanthaceae (and not Scrophulariaceae as treated by Bremekamp l.c.). This is supported by Champluvier (1991) in his revision of the genus *Staurogyne* Wall., etc. Moreover, description of the genus *Staurogyne* given by him fully supports the change of *Paraboa nagalandiana* to the genus *Staurogyne* Wall. but for slight difference in the size and form of the bilabiate corolla and in the form of the stigma. Specimens of *Paraboa nagalandiana* did not have fully bloomed flowers and matured fruits. Bilabiate corolla with broad distinctly veined lobes characteristic of *Staurogyne* was not evident in our specimens. However, the flower buds of *Staurogyne paniculata* collected from a very nearby locality of Manipur on examination shows similar corolla lobes as those of our plant under consideration; gynoecium in bud stage also is similar in both the plants. Thus our material fully agrees with the details of *Staurogyne paniculata* (Wall. ex T. Anders.) O. Ktze., to which it deserves to be reduced as a synonym.

Staurogyne paniculata (Wall. ex T. Anders.) O. Ktze. Rev. Gen. Pl. 2: 497. 1891; Bremekamp in Reinwardtia 3: 196. 1955.

Ebermaiera paniculata Wall. ex. T. Anders. in Journ. Linn. Soc. 9: 453. 1867 (Type: East Manipur, 25-6-1834, Sabir Mahomed ex Griffith (new Distribution no. 6082 K, photo. CAL!)); Hook. f. Fl. Brit. Ind. 4: 401. 1885.

Paraboa nagalandiana Deb & Dutta in Journ. Bombay nat. Hist. Soc. 85(1): 168. t. 1. 1988 (Type: Nagaland, Narum, Dec. 1907, *A. Meebold* 7394, holo. CAL!; Sarpung, Dec. 1907, *A. Meebold* 7230, para. BSI). syn. nov.

Distribution: Manipur, Nagaland, Burma.

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MARCH 26, 1994

D.B. DEB
RATNA DUTTA
Central National Herbarium,
Indian Botanical Garden,
Howrah 711 103.

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33. *TEUCRIUM VISCIDUM* BL. (LAMIACEAE) - AN INTERESTING DISTRIBUTIONAL RECORD FROM ORISSA

Teucrium viscidum Bl. (Syn. *T. stoloniferum* Buch.-Ham. ex Benth.) so far restricted to Sikkim Himalaya, Bengal, Khasia hills and Oudh in India has been found to occur in Orissa. Haines (1921-25) included this species in the Botany of Bihar and Orissa on its probable occurrence without having made any collection or seen in the field. Gamble (1915-36), Mooney (1950), Panigrahi *et al.* (1964) and others too have not reported this species from the area. The present report is not only a new record for Orissa but also extends the restricted distribution of this interesting taxon.

Teucrium viscidum Bl., Bijdr. 827. 1827; Mukerjee, Rec. Bot. Surv. India 14: 218. 1940; Keng in Steenis, Fl. Males. I. 8: 318. f. 4. 1978. *T. stoloniferum* Buch.-Ham. ex Benth. in Wall. Pl. As. Rar. 1: 58. 1830; Hook. f. Fl. Brit. India 4: 700. 1885; Haines, Bot. Bihar & Orissa 2: 752 (789). 1924.

Erect, stoloniferous herb, 30-60 cm; stems pubescent and glandular-pubescent. Leaves ovate or ovate-oblong, 3.5-7 x 2-4.5 cm, deeply crenate to crenate-serrate, acute, minutely sparsely pubescent on both sides, base subcordate, truncate or shortly cuneate; petiole 1-2.5 cm. Racemes terminal and axillary, simple or panicled, lax-flowered, 4-6 cm long or in fruit up to 8 cm long densely pubescent and glandular-pubescent; pedicels 2-3 mm; bracts lanceolate, 2-3 mm long, pubescent. Calyx campanulate, 2.5-3 mm long, pubescent or glandular-pubescent outside, 3 upper teeth short, ovate or triangular, obtuse, 2 lower ones acute, subequal; calyx in fruit urceolate or globose, 3-6 mm, glandular-hairy,. Corolla pinkish to purple, *c.* 7 mm long, tube included or slightly exserted, without a hair-ring inside, limb seeming 1- lipped, the lower lip 3-lobed, slightly concave, associated with two upper lobes forming a 5-lobed whole. Nutlets slightly flattened, ovoid or globoid, 1.5 mm long, surface of contact large, oblique, lateral.

Badomukkabadi and Dudurchampa, Similipahar, Mayurbhanj, North Orissa in shady places - *Saxena, Brahmam & Prabhakar Rao* 4643, 4658 (RRL-B), Fl. & Fr. 10-6-82.

Distribution: Sikkim Himalaya, Bengal, Khasia hills, Oudh. Myanmar, Thailand, Indo-China, Hong-Kong to China, Korea, Formosa, Malaysia, Japan.

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H.O. SAXENA
M. BRAHMAM
N.C. ROUT
Regional Research Laboratory,
Bhubaneswar 751 013,
Orissa.

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34. FIRST RECORD OF THE ALLIGATOR WEED, *ALTERNANTHERA PHILOXEROIDES* (MART.) GRISEB. FROM PUNE, MAHARASHTRA

(*With a text-figure*)

The genus *Alternanthera* Forsk. is represented in India by five species, namely *A. sessilis, A. pungens, A. tenella, A. paronychioides* and *A. bettzichiana* (Sivarajan and Mathew 1984, Naik and Pokle 1985). These plants are known to attain weed proportions.

One such aquatic emergent weed showing close resemblance to the genus *Alternanthera* was seen growing profusely during October 1992 in the river Mutha, which flows through Pune city. Though two of us had spotted this plant growing in the same river, during 1990, it failed to attract attention of even the angiosperm taxonomists probably because it had not reached weed proportions then. Two earlier reports, one for the river Mutha and its surroundings (Ghate and Vartak 1981) and the other for aquatic angiosperms of entire Maharashtra (Karthikeyan *et al.* 1982) have not mentioned this plant.

This weed was found growing luxuriantly along the slow moving and sewage polluted parts of the river Mutha. The plant attains a length of over two metres. Flowering was observed during April and May. Because no species of *Alternanthera* commonly found in India bears flowers in peduncled heads, there was delay in identification of this plant. Herbarium collections in Botanical Survey of India (BSI), Western Circle, Pune and Agharkar Herbarium of the Maharashtra Association for the Cultivation of Science (AHMA), Pune, were also not helpful because this plant is not in their collections. We even recently mentioned about this unidentified weed at the "National Conference on Recent Advances in Phytotaxonomy" held at Aurangabad, in June 1993.

After a thorough examination of the material at hand and literature survey, we now report this plant to be *Alternanthera philoxeroides* (Mart.) Griseb., popularly known as the alligator weed. Our identification is based on the description and key given by Maheshwari (1964), Bennet (1979) and Sivarajan and Mathew (1984).

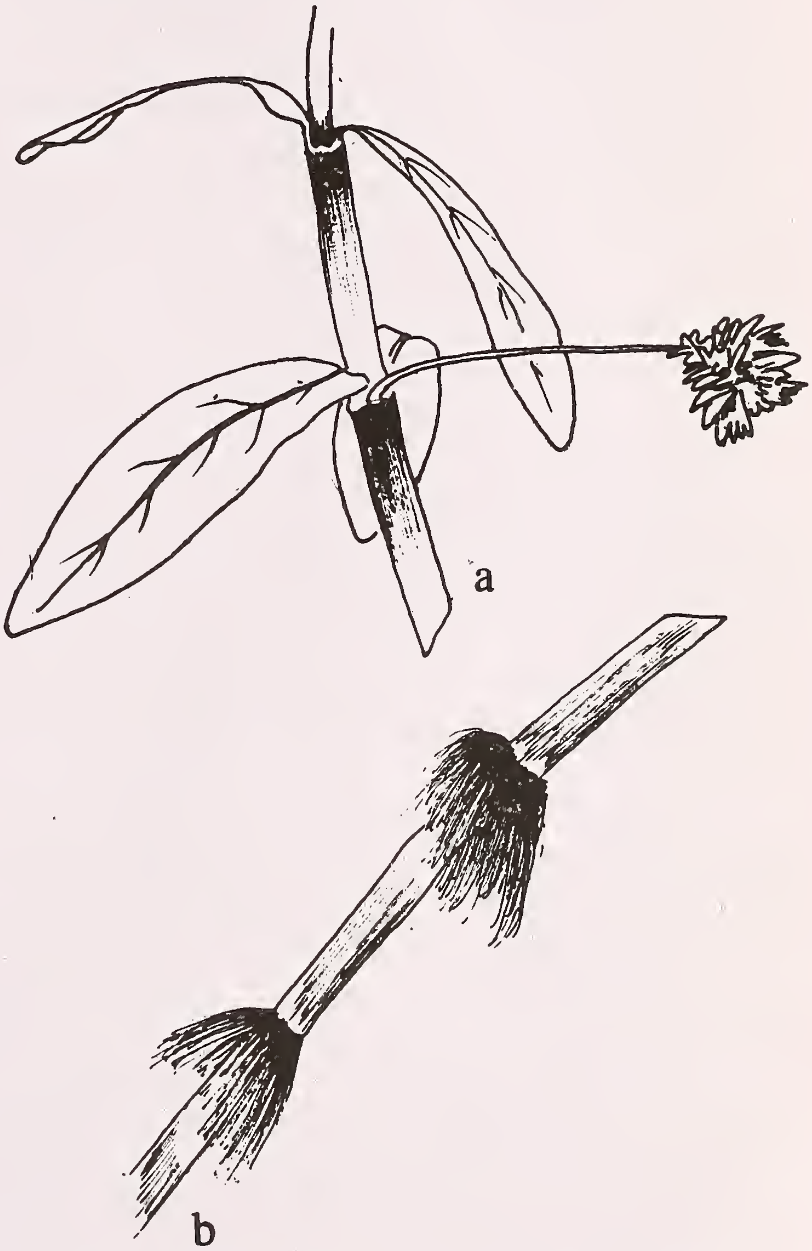

Fig. 1. *Alternanthera philoxeroides* (Mart.) Griseb.
a. Showing the stem and peduncled flower;
b. Showing rooting at lower nodes.

Singh and Singh (1985) stated that in Manipur the plant is locally known as 'komprek' and that all parts of the plant except roots are eaten, raw or cooked. They are sold in bundles in markets from May to July in Manipur. In West Bengal it is locally known as 'jal-sanchi' (Jain 1991). As reported in 'The Wealth of India', the plant has high iron content and can be used as a salad. Methane can also be produced from anaerobic fermentation of the plant. The plant can be used as a tertiary filter for domestic sewage as it reduces the suspended solids, total Kjeldahl nitrogen, total phosphorus, B.O.D. and total organic carbon levels in domestic sewage. The plants grown in domestic sewage are reported to be free from toxic levels of trace heavy metals (Anon. 1985). Its use as a vegetable is well known in tribal areas of Assam, Sikkim and Bihar (see Jain 1991). Raju (1986) has reported that it is locally used by some as a green vegetable and by most others as fodder for their cattle and pet rabbits. In one instance, as reported by him, the plant was cultivated in Hanamkonda, Andhra Pradesh, as a forage crop. Madhusoodanan and Ajit Kumar (1993) have reported that the plant is sold in Ernakulam, Kerala, as a delicious leafy vegetable and is locally called as 'Kozhuppa'.

From our observations it is quite apparent that this is a fast growing problematic plant. We therefore agree with Sankaran and Narayanan (1971) and Naithani and Raizada (1976), who warn about the aggressive qualities of this plant. We feel that this may become yet another nuisance weed like water hyacinth.

Raju (1986) mentions that the insect species *Agasicles hygrophila* Selman and Bogt (Flea beetle), *Amynothrips andersoni* O'Neill (Thrips) and *Vogtia malloi* Pastrana (Stem borer) were introduced into USA from Argentina for biological control of the alligator weed.

Some salient features of this plant are: decumbent hollow stem rooting at lower nodes; leaves opposite, fleshy, oblong lanceolate and narrowed at base; flowers shining silvery white, in long peduncled heads, borne in only one axil of a node; tepals white, apex subacute; stamens five, united below; staminodes equal to the height of the stamens, broader than the filaments, tips divided into 2-4 narrow teeth; ovary rounded at the apex; style short; stigma globose (Fig. 1).

The weed is believed to be originally from Brazil, South America. As far as the distribution of this weed in India is concerned, there are reports from West Bengal and Bihar (Maheshwari 1964), Karnataka (Sankaran and Narayanan 1971), Assam (Baruah and Choudhury 1974), Madhya Pradesh (Naithani and Raizada 1976), Tripura (Deb 1981), Manipur (Singh and Singh 1985), Andhra Pradesh (Raju 1986), Uttar Pradesh (Pangtey and Samant 1989), Delhi (Lal and Shah 1990), Punjab (Bir, Sharma and Singh 1992), Kerala (Madhusoodanan and Ajit Kumar 1993). This report therefore forms the first record of the alligator weed from Pune, Maharashtra.

It is interesting, however, to note that although this species was identified by Maheshwari in 1964, apparently it was collected as early as 1940 by Floyd from West Bengal and Bihar (Baruah and Chowdhury 1974).

The specimens are now kept in the AHMA at Agharkar Research Institute, Pune (Voucher Specimens AHMA 17890 to 17892). One specimen will be donated to BSI, Pune.

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G.K. WAGH
H.V. GHATE
Post Graduate Research Centre,
Department of Zoology,
Modern College, Pune 411 005.
VINAYA S. GHATE
Agharkar Research Institute,
G.G. Agarkar Road, Pune 411 004.

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35. A REPORT ON THE OCCURRENCE OF *ANTIDESMA THWAITESIANUM* MUELL. - ARG. (EUPHORBIACEAE) FROM SOUTH ANDAMANS

INTRODUCTION

During botanical exploration of Mt. Harriet Hills (South Andamans) we came across some interesting specimens of *Antidesma* species. The specimens were critically studied at CAL and identified as *Antidesma thwaitesianum* Muell.-Arg. Airy Shaw (1972a, 1972b, 1981) reported the occurrence of this species from Andaman Islands on the basis of an old collection by Parkinson deposited at Kew (K.). This species has never been reported again from Andaman Island after Parkinson's collection (Parkinson, 575, without specific locality 15-5-1915). Chakrabarty & Balakrishnan (1992) in their revisionary work, reported that no specimen of this species from Andaman Islands is traceable in Indian herbaria. The recent exploration of the slopes of Mt. Harriet ranges revealed small populations of this species growing at Wrightmyo and Kalatang forests of the Harriet ranges. Though *Antidesma thwaitesianum* Muell.-Arg. has a wide phytogeographical distribution from Sri Lanka to South-East Asia, in the Indian flora, it is confined to the Andaman Islands. Being a very rare and interesting species, an illustrated account is given below to facilitate its identification.

Antidesma thwaitesianum Muell.-Arg. in DC., Prodr. 15(2): 263. 1866; Airy Shaw in Kew Bull. 26: 360, 462. 1972 & in Kew Bull. Ad. ser. IV. 217. 1975 & in Kew Bull. 36: 364. 1981; Mandal & Penigr. in J. Eco. Tax. Bot. 4: 255. 1983; T. Shakrab.

& Balakr. in J. Econ. Tax. Bot. Ad. Ser. 9: 19. 1992. *A. bunius* sensu Hook. f., Fl. Brit. India 5: 358-9. 1887 (Pro parte); Pax & Hoffm. in Engl., Pflansenr. 4, 147(15): 160 - 1. 1992. non (L.). Spreng. 1825.

Shrubs or small trees, *c.* 6 m tall, branchlets greyish, sparsely lenticellate. Leaves 8-19 x 3-8 cm, elliptic to elliptic oblong, or ovate-lanceolate, acuminate at apex, acute or rounded at base, coriaceous, glossy, lateral nerves *c.* 10 pairs, thin, flattened above, thinly raised beneath, midrib flattened above, raised, tapering beneath, venation finely reticulate, tessellated, petiole 1 cm long, pulvinate at apex, infructescence usually cauliflorous, very rarely axillary on old leaves, *c.* 7 cm long, fascicled. Fruits 7 x 5 mm, flattened, quadrate orbicular drupes with persistent stigma at apex, greenish turning reddish to finally blackish.

Fr.: April.

Ecology: Very rare in the inland evergreen forest at low altitude.

Distribution: Andamans (India); Sri Lanka, Indo-China, Myanmar (Burma), Thailand, Sumatra, Philippines and Borneo.

Specimen examined: Wrightmyo 16-4-1989, S.P. Mathew 20264 (CAL & PBL)

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February 7, 1994

SAM P. MATHEW
SUSAN ABRAHAM
Department of Botany,
University of Kerala,
Trivandrum, Kerala.

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36. A REPORT ON THE THREATENED ORCHIDS OF MANIPUR

As many as 34 species of orchids from North-East India are listed among the threatened plants of India, out of which only three species, namely *Dedrobium bensoniae* Reichb. f., *Renanthera imschootiana* Rolfe., and *Vanda coerulea* Griffith ex Lindl., are recorded from Manipur (Jain and Shastry 1983). However, I have observed three more species of threatened orchids growing in the hills and glades of Manipur.

Paphiopedilum spicerianum (Reichb. f.) Pfitz., an endemic and endangered plant recorded from Assam also grows in the Barak watershed of Manipur. This highly ornamental orchid is seen to grow in great abundance on the steep rocky cliffs of the Barak river in the Jiribam and Tamenglong Sub-divisions.

Pleione hookeriana (Lindl.) Williams, a rare orchid that is recorded to be endemic to Sikkim, Arunachal Pradesh, Bhutan and Nepal also grows in Manipur at elevations 2700-3000 m above MSL.

Galeola falconeri Hook. f., an endemic and rare orchid of Sikkim and Arunachal Pradesh is also found in the parallel folds of the Shiroy-Kasom hill ranges of Manipur.

It is next to impossible to collect and grow *Galeola falconeri* - a saprophyte, in orchid gardens. However, the *Paphiopedilum spicerianum* and *Pleione hookeriana* are successfully grown in the state owned orchid gardens of Manipur, as a part of ex-situ conservation of the threatened orchids of the State.

A new genus of orchid "*Kalimpongia*" was discovered in Manipur at the elevation 1700-2000 m (Pradhan 1977) and three different species of orchids, namely *Kalimpongia narajitii*, *Scheonorchis manipurensis* and *Ascocentrum ampullaceum* var.

aurenticum have been found to be endemic to Manipur. As the above orchids grow in a very small geographic area, it is logical that they also may be listed among the threatened plants of India.

February 7, 1994 V. RAMAKANTHA
Deputy Conservator of Forests, Wildlife,
Aranya Bhavan, Malleshwaram,
Bangalore 560 003.

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37. *WOODSIA LANOSA* HOOK. (WOODSIACEAE) FROM GARHWAL HIMALAYA: REDISCOVERED

While investigating the pteridophytic flora of Roopkund area of Garhwal Himalaya, one of us (KB) collected a rare and threatened fern (*Woodsia lanosa* Hook.). A perusal of earlier literature shows this fern was not collected from Garhwal Himalaya after the original collection and subsequent workers included this on the authority of previous reports (Hope 1903, Duthie 1906, Dhir 1980, Singh *et al.* 1986, Khullar *et al.* 1987 and Pande 1990). It is now being reported from Garhwal Himalaya after its first report by Duthie in 1884.

Woodsia lanosa Hook., Syn. Fi 1., 47. 1866; Clarke, Trans. Linn. Soc. Lond., II, Bot. 1: 435. 1880; Beddome, Handb. Ferns Brit. India, 22. 1883; Duthie, Cat. Pl. Kumaun, 230. 1906; Dhir, Bibliotheca pteridologica, 1: 62. 1980; Singh, Chaudhery & Rao, Ind. J. For., 9: 163. 1986; Khullar, Sharma & Chaudhary, West Himal., 1: 374. 1987; Pande, Indian Fern J., 7: 174. 1990.

Gymnogramme andersoni Bedd., Ferns Brit. India 190, 1866; Hope, J. Bombay nat. Hist. Soc., 100. 1903 (pro parte).

Voucher specimens are housed in the herbarium, Department of Botany, Kumaun University Campus, Almora. Chamoli Garhwal: Roopkund near Bedini Bugyal, 3300 m dated Sept., 1991, *Kusum Bhandari* 15.

Duthie (1884) cf. Hope (1903), Duthie (1906), Dhir (1980), Singh *et al.* (1986: Sheet in CAL 3706), Khullar *et al.* (1987: Sheet in DD) reported this rare fern from Fulmar pass in Tehri Garhwal and Kauri pass in Chamoli district. Not collected since then. Further, there is no collection of this species from Garhwal in BSD (cf. Singh *et al.* 1986).

Extremely rare fern that grows in rock crevices between altitude of 3000 and 3600 m. This taxon reported herein is not likely to survive unless proper steps are taken for its conservation.

Financial assistance received from CSIR New Delhi is thankfully acknowledged.

March 22, 1994 P.C. PANDE
KUSUM BHANDARI
Department of Botany,
Kumaun University Campus,
Almora 263 601.
U.P.

38. *ERAGROSTIS ASPERA* (JACQ.) NEES : AN ADDITION TO THE GRASSES OF ORISSA

(*With a text-figure*)

During the study of the grasses collected from three districts of Orissa, I came across a taxon, *Eragrostis aspera* (Jacq.) Nees, which has not been earlier reported from the state (Mooney 1950, Jain *et al.* 1975). Earlier this grass has been reported from Madras and Southern Konkan, Marathwada, Rajasthan

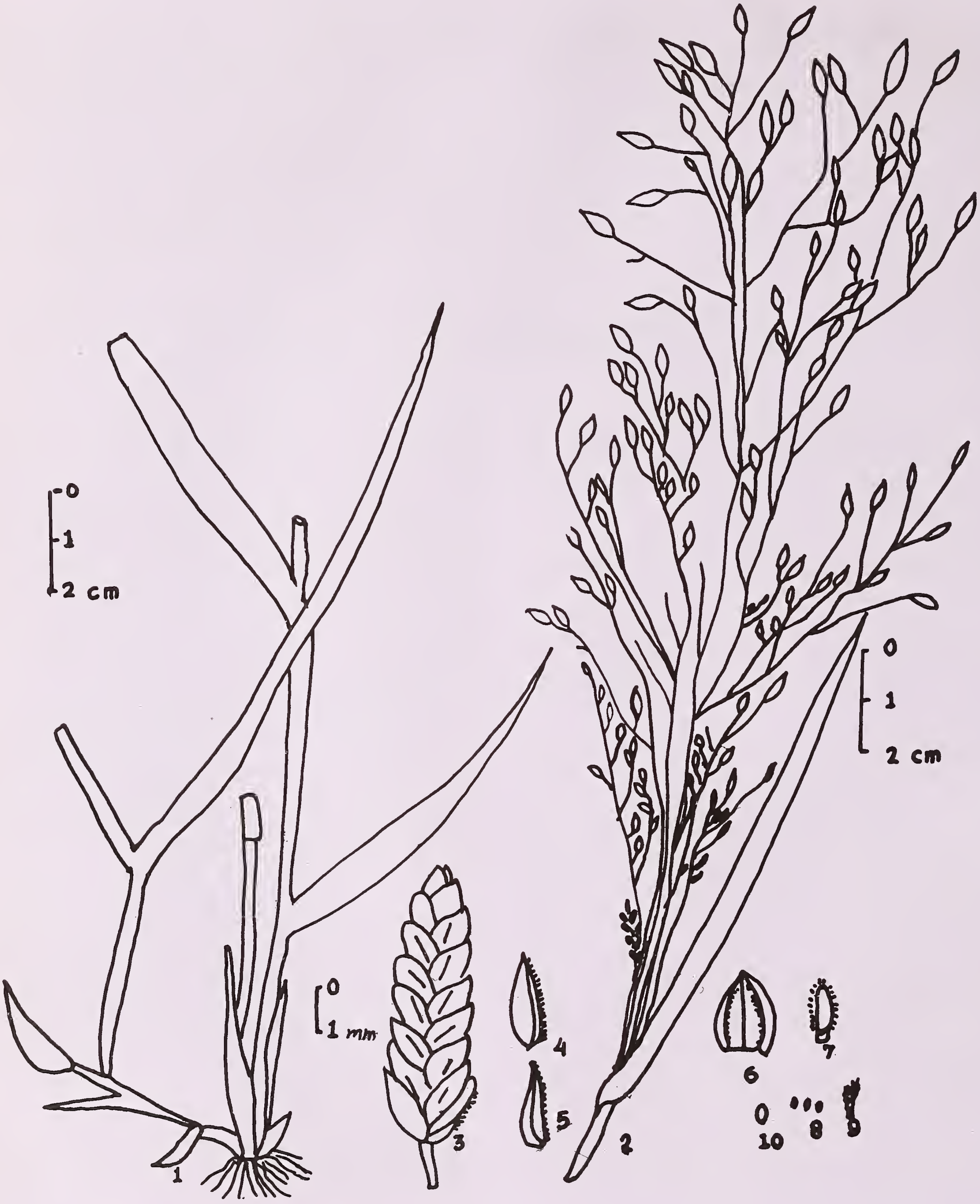
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Fig. 1. *Eragrostis aspera* (Jacq.) Nees
1. Habit; 2. Inflorescence; 3. Spikelets; 4. Lower glume; 5. Upper glume; 6 & 7. Lemma and its palea; 8. Stamens; 9. Ovary; 10. Caryopsis.

and Bihar. It grows in cultivated fields on high hills (910-1220 m) of Kalahandi, Gajpati and Ganjam districts of Orissa. The detailed description of the taxon is available in the literature, hence the present notes only deal with its correct nomenclature, distribution and ecology. An illustration is also provided. The voucher specimens are deposited in the herbarium, Bhagalpur University. The identification of the specimens have been confirmed at the Central National Herbarium (CAL).

Eragrostis aspera (Jacq.) Nees, Fl. Afr. Austr. 468. 1841; Hooker, Fl. Brit. Ind. 7: 314. 1896; Bor, Gr. Burma, Ceylon, Ind. & Pak. 501. 1960.

The plant frequently grows in gravelly soils in shifting cultivation fields (Bogoda or Poda, Oriya) on hills.

Distribution: INDIA: Bihar, Rajasthan, Western India and South India; Africa, Mascarene Islands.

Flowers: August-December.

Specimens examined: Nijamaska (1065 m), Thaumal Rampur block, Kalahandi district, Jha 5TR; Gangabad, Koinpur, Gajpati district, 975 m, Jha 21K; Marmalia, Thumba, Ganjam district, 975 m, Jha 8T; Kathpatani, Rudhapadar, Ganjam district, Jha 12R.

October 12, 1993

R.R. JHA
Badlao Foundation,
Mihijam, Dumka 815 354,
Bihar.

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39. STUDIES ON THE SPORE MORPHOLOGY OF *OLEANDRA UNDULATA* (WILLD.) CHING AND *O. WALLICHII* (HOOK.) PRESL.

(*With a plate*)

INTRODUCTION

Recently, some of the important contributions on the spore morphology of ferns and fern-allies were made by Erdtman and Sorsa (1971); Wilce (1972), Wagner (1974), Mitui (1977), Lugardon (1978), Tryon and Tryon (1982) and others. In India some of the contributions were provided by Nayar (1964), Joshi (1966-67), Devi (1973, 1977, 1981), Verma and Khullar (1978), Bir and Bhusri (1985), etc.

However, the family Oleandraceae received little attention in the context of spore morphological studies (Braggio 1966, Devi and Nayar 1971, Liew 1977, Harmata and Kornas 1978). This communication aims to present comparative spore structures of *O. undulata* and *O. wallichii.*

MATERIAL AND METHODS

The spore samples were collected from herbarium specimens and were treated by the acetolysis technique (Erdtman 1952). The terminology, namely exine processes, ornamentation, stratification and laesural features were followed after Erdtman *et al.* (1961).

The descriptions are based on light microscopic observations and in case of *O. undulata*, spores were also examined under Scanning Electron Microscope. The magnification of the photographs has been indicated in the figures.

OBSERVATIONS

Oleandra undulata (Willd.) Ching, Lingnan Sci. J. 12: 565. 1933. *O. cumingii* J. Smith, Hook. Sp. Fil. IV. 158.

The specimens were collected from a dense *Quercus* forest, at an elevation of 2100 m.a.s.l., growing as lithophytes on exposed, rocky walls or as epiphytes on *Quercus* tree trunks. The plant is rare in its occurrence in Garhwal Himalaya (GUH- 12103).

Spores monolete, bilateral, 23.8 x 32.5μ (21-24.5 x 29.8-34.7μ) plano-convex to slightly concavo-convex in lateral view and oblong to elliptic in polar view. Leasura 18.1μ long, tenuimarginate. Exine 2.4μ thick, brown, densely spinulose bearing dark brown, sharp-pointed, short spinules about 1.9μ tall. Perine deep brown, surface under the SEM densely spinulose bearing slender, sharp spinules with sharp pointed apices, about 2.1μ tall (In L.M. observations). Perine adhering to the exine and folded into elongated, irregular, thin (sometimes scarcely sinuous) folds coalesced to form an irregular lophate pattern with crenate crests and protruding up to 5.1μ from the exine surface (Plate 1, Figs. 1-4).

O. wallichii (Hook.) Presl, Tent. Pterid. 78. 1836.

The specimens were collected from a moist, shaded forest at an elevation of 2000 m.a.s.l., growing on damp rock surfaces or as epiphyte on *Rhododendron* tree trunks. This species is also rare in its occurrence in Garhwal Himalaya (GUH-12065).

Spores monolete, bilateral, 26.3 x 36.8μ (24.5 - 28 x 35 - 38.5μ), plano-convex to slightly concavo-convex in lateral view and oblong to elliptic in polar view. Laesura 17.5μ long, tenuimarginate. Exine 2.2μ thick, brown, spinulose with short, sharp-pointed, sparse spinules about 2.2μ tall. Perine dark brown, densly spinulose with spinules up to 4.2μ tall with sharp pointed spices, closely adhering to the exine and folded into crowded, elongated, thin, irregular folds coalesced forming a reticulate pattern with irregular reticulations on the surface and protruding up to 3.6μ from the exine surface with irregular, crenate crest (Plate 1, Figs. 5-6).

DISCUSSION

Oleandra undualata and *O. wallichii* represented almost similar type of spore morphology (monolete and bilateral), the perine is densely spinulose, however, the former bears small spinules up to 2.1 μ tall while in the latter, spinules are about 4.2 μ tall on the perine folds. *O. undualata* perine folds are coalesced to form an irregular lophate pattern and protruding up to 5.1 μ, whereas *O. wallichii* perine folds are coalesced giving a reticulate pattern and protrude up to 3.6 μ from the exine surface.

In general, the spores of *Oleandra* are uniformly echinate and bear wing like folds (Braggio 1966, Liew 1977, Harmata and Kornas 1978, Tryon and Tryon 1982) and most of the palynologists treated their resemblance with the Dryopteroid rather than Davalloid ferns. However, the echinate processes are quite prominent in *O. wallichii* and the perine folds are either coalesced to form an irregular lophate pattern (*O. undulata*) or reticulate pattern (*O. wallichii*).

ACKNOWLEDGEMENT

Our sincere thanks are due to Dr. D.D. Thakur, Director, Wadia Institute of Himalayan Geology, Dehradun, India for providing SEM facilities.

October 12, 1993

PREETI PAINULI
R.D. GAUR
Department of Botany,
H.N.B. Garhwal University,
Srinagar, Garhwal 246 174,
U.P.

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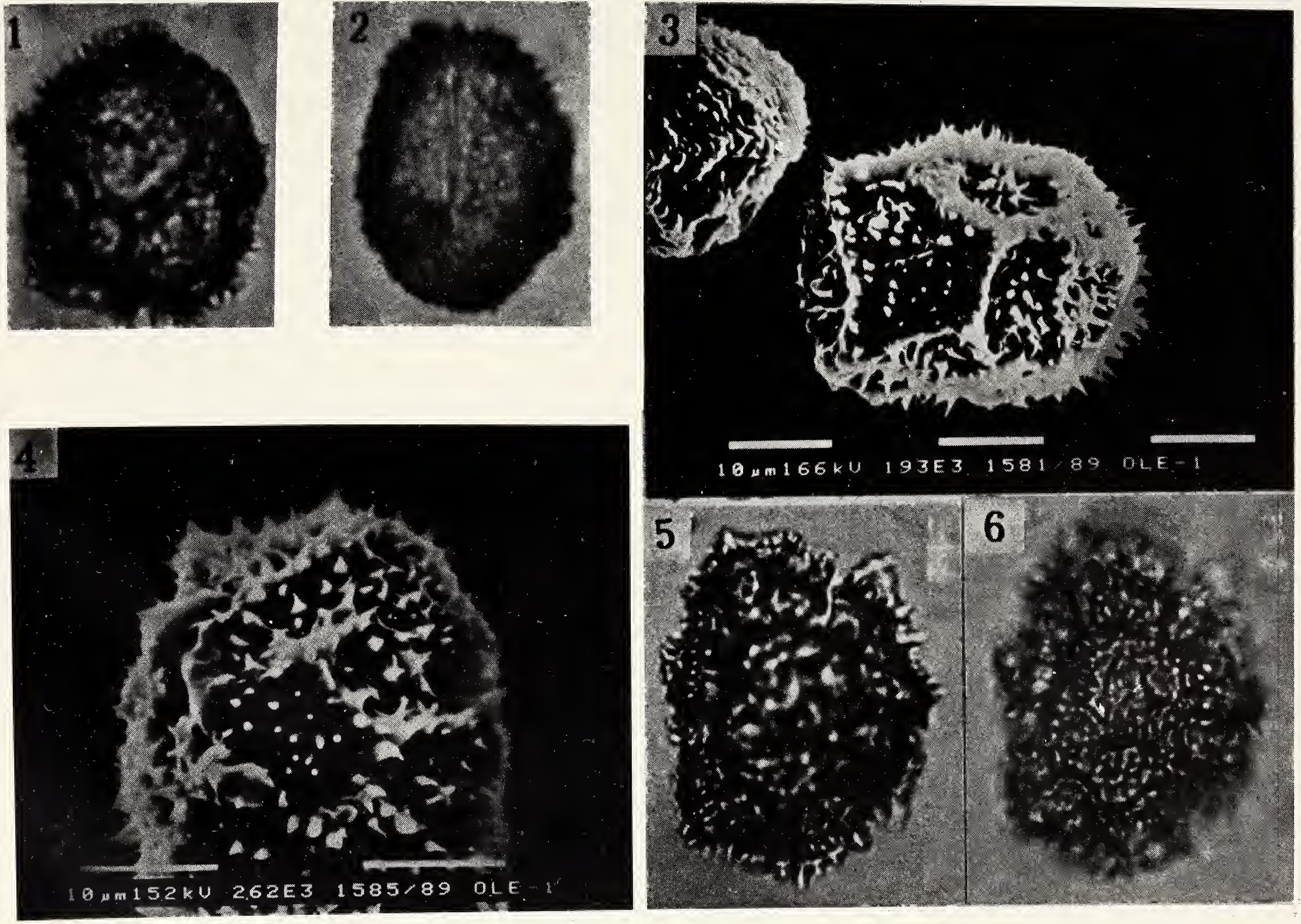
PLATE 1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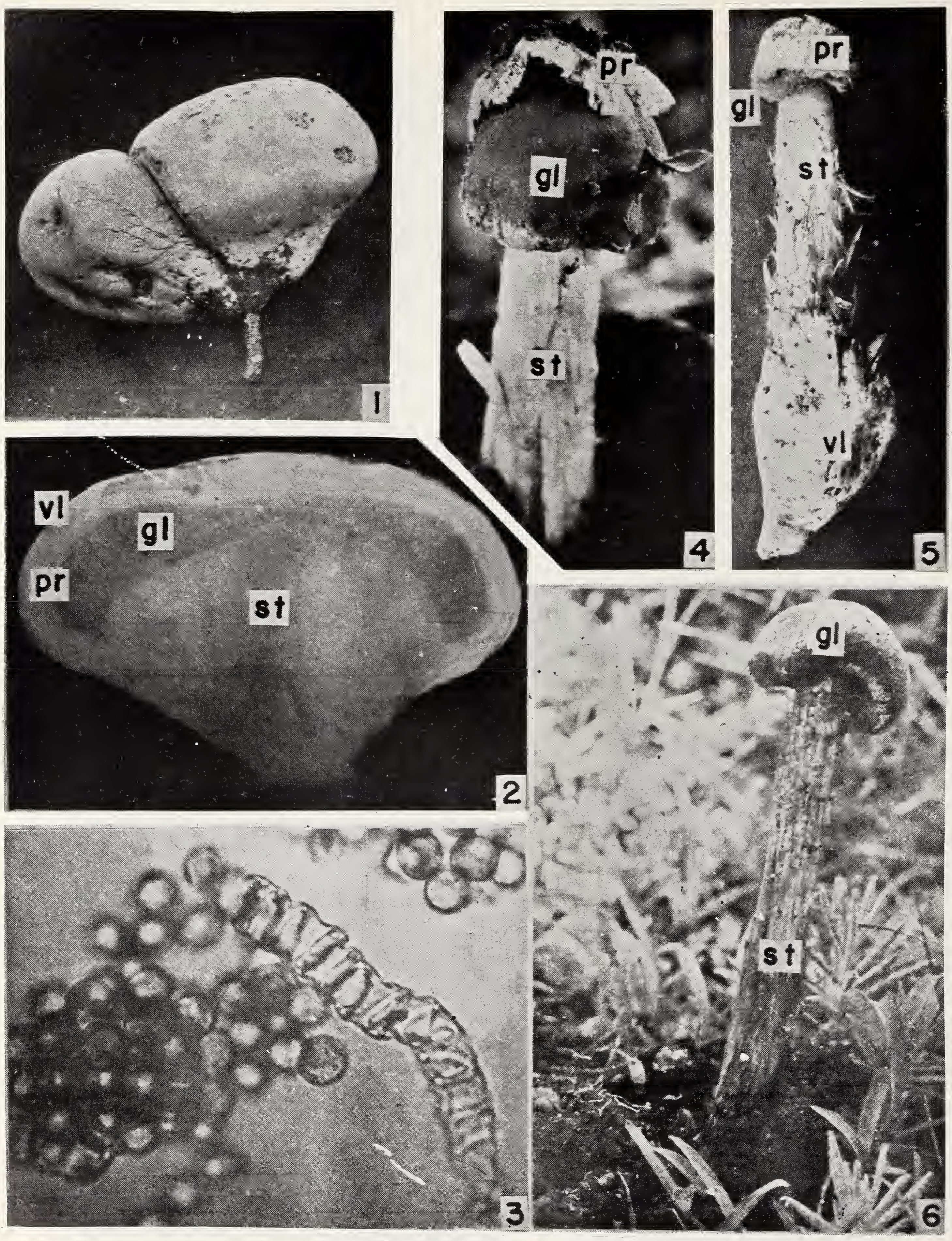
Figs. 1-4. *Oleandra undulata* — (L M Figs.) 1. perine folds; 2. laesura (x 1000). (SEM Figs.) 3. perine folds with spinules (x 1930); 4. magnified view of perine surface indicating spinules (x 2620).

Figs. 5-6. *Oleandra wallichii* — (L M Figs.) 5. spinulose perine; 6. perine folds and surface pattern (x 1000, unacetolysed).



Figs. 1-6. *Battarea stevenii* (Lib.) Fr.

1. A pair of young fruiting bodies on woody rhizomorph dug out of the soil, x 0.7; 2. Fruiting body longitudinally cut to show dome-shaped gleba and stipe enclosed by the volva, x 1; 3. Basidiospore mass with an annularly thickened elater, x 1150; 4. Fruiting body with a bell-shaped gleba and stout stipe: note the peridium falling away in one piece, x 0.5; 5. Fruiting body dug out of soil to show dome-shaped gleba, stout scaly stipe and cup-like volva at the base, x 0.4; 6. Overground part of a mature fruiting body at the habitat, x 0.3.

Abbreviations: gl, gleba; pr, peridium; st, stipe; vl, volva.

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40. OCCURRENCE OF *BATTAREA STEVENII* (LIB.) FR. (TULOSTOMATACEAE) IN MYSORE - A NEW RECORD FROM SOUTH INDIA

(*With a plate*)

OBSERVATIONS

As uncommon gasteromycete, was consistently observed and collected at Manasagangotri, Mysore, Karnataka, South India during south-west monsoon of 1986-93. The curious nature of its fruiting body prompted us to characterise and identify the taxon.

The fruiting body emerges through the soil exerting considerable force during the rainy season. Cracks appear on the soil surface before the emergence of the fruiting body. Removal of the surface soil at that site, 25-30 cm deep, reveals 1-3 closed large basidiocarps arising from a branched or unbranched woody rhizomorph (Pl. 1, Fig. 1). Each such fruiting body consists of volva enclosing the stipe and the dome-shaped gleba protected by the peridium (Pl. 1, Fig. 2). The gleba is traversed by reticulate capillitium and spores. The spores are intermixed with coarse hyaline hyphal threads of the capillitium and free elongated annularly and/or spirally thickened elaters (Pl. 1, Fig. 3). The spores are globose to sub-globose; yellowish-brown; finely punctulate; 6-7 µm in diameter. After sometime the stipe elongates and pierces through the single-sheathed volva, which remains underground as a cup-like involucre (Pl. 1, Fig. 5). The volva is very large and measures 10 cm in height, 8-10 cm in diameter and 25-32 cm in circumference. The young overground part of the fruiting body simulates a mushroom (Pl. 1, Fig. 4), but 2-3 days after its emergence and by the time stipe attains a considerable height (25-30 cm) its appearance is entirely different from that of a mushroom (Pl. 1, Fig. 6). The stipe and peridium together measure up to 30 cm in height. The bell-shaped peridium is situated apically on the stout scaly stipe and measures 6-9 cm in diameter and 5-7 cm in height (Pl. 1, Fig. 4). It gradually assumes a discoid shape as it reaches maturity (Pl. 1, Fig. 6). The stipe alone is about 25 cm long and 4-5 cm in diameter. The exterior of the stipe is covered with long coarse, fibrillose, lacerate overlapping scales which show a tendency to peel off (Pl. 1, Figs. 4-6).

The peridium opens in a circumcissile manner and its membranous outer layer falls off in one piece (Pl. 1, Fig. 4), exposing the glebal contents - spores, elaters and collapsed capillitium. Only rarely, remnants of the membranous peridial layer are seen adhering to the fertile spore bearing portion (Pl. 1, Fig. 5).

During emergence the fruiting body emits a foetid smell attracting flies. The activity of the visiting flies appears to help in spore dispersal to some extent. However, the main agents of spore dispersal are the highly hygroscopic elaters and the wind. The spore dissemination by elaters in the present taxon is functionally analogous to that found in the sporangia of Myxomycetes and sporophytes of Liverworts.

IDENTITY OF THE TAXON

The presence of peculiar tracheid-like elaters in the gleba, the characteristic circumcissile dehiscence of the sporocarp, massive volva at the base of the fruiting body and the lacerate scales on the stipe lead us to identify the present taxon as *Battarea stevenii* (Lib.) Fr.

The genus *Battarea* Pers. is widely distributed and found in sandy soils of U.S., Europe, South America, New Zealand (Bessey 1968) and rarely in Pakistan and India (Ahmed 1939, 1952). The genus comprises only two species, namely *B. phalloides* (Diks.) Pers. reportedly endemic to Southern England (Ainsworth 1971, Dring 1973, 1974) and *B. stevenii* reported from Rohtak, Punjab, North India by Ahmed (1939). A perusal of the literature (Ahmed 1939, 1952; Bessey 1968, Rangaswamy *et al.* 1970, Dring 1973, 1974; Biligrami *et al.* 1979) reveals that the present finding forms the first record of *B. stevenii* from South India. Further, Ahmed (1939, 1952) reported the presence of three-sheathed volva in the form described by him, while the present taxon is found to possess a consistently single-sheathed volva. Further, the solid stipe, peridium and volva are consistently larger in size in the present form.

A systematic study of the higher fungi in and around Mysore would definitely reveal the occurrence of many more interesting species.

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We sincerely thank Prof. K. Natarajan, Centre for Advanced Studies in Botany, Madras University, Madras for his help in the identification of the taxon.

February 12, 1994

G.R. SHIVAMURTHY
H.G. VIJAY GOPAL RAJ URS
K.B. SADANAND
Department of Studies in Botany,
Manasagangotri,
Mysore 570 006,
Karnataka.

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MOULT IN THREE SPECIES OF BULBULS OF THE GENUS *PYCNONOTUS* AT TIRUPATI HILLS OF THE EASTERN GHATS, INDIA[1]

S. Balachandran, K.K. Mohapatra and S.A. Hussain[2]

(*With four text-figures*)

Key words: moult score, primary moult, post nuptial moult, post-juvenile moult, suspended moult, moult duration, brood patch, recapture

Moult in three species of bulbuls, namely Whitebrowed *Pycnonotus luteolus*, Redwhiskered *Pycnonotus jocosus* and Redvented *Pycnonotus cafer* have been studied at the Tirupati Hills of the Eastern Ghats in India. The primary moult (commencement, duration and its relation with other moults) is described. Interspecific variation in commencement and duration is discussed. It is established that in Redwhiskered and Redvented the post-juvenile moult is rapid and shorter than the post-nuptial moult of adults. This study clearly indicates that all the adults of the three species undergo a complete post-nuptial moult soon after breeding is over. The post-juvenile moult starts one month after fledging.

INTRODUCTION

The Eastern Ghats are an important entity in the zoogeography of peninsular India and the distribution of the fauna and flora of the region has not been documented in detail. Whistler and Kinnear (1932-37) in a pioneering report based on the Vernay Scientific Survey conducted in 16 locations of the Eastern Ghats, touched upon some aspects of occurrence and distribution of the avifauna. Birds of the Eastern Ghats have been listed and described by Abdulali (1945, 1953), Raju and Selvin (1971), Raju and Price (1973), Hussain *et al.* (1976), Price (1979), and Beehler *et al.* (1987). Price (1979) described the seasonality of birds in the Eastern Ghats of Andhra Pradesh, and discussed briefly the moult pattern of the resident species.

The moult of Indian birds is poorly understood and little is known about the moult of any Indian bulbul. Some aspects of the moult cycles in a few Indian birds have been described (Naik and Naik 1965, Naik and Andrews 1966, Naik 1970). This paper provides details of the moult of three species of Bulbuls, namely Whitebrowed *Pycnonotus luteolus*, Redvented *Pycnonotus cafer* and Redwhiskered *Pycnonotus jocosus* Bulbuls in the Tirupati Hills of Eastern Ghats.

STUDY AREA AND METHODS

The Tirupati hills (13° 40' N, 79° 20' E) form a part of the Eastern Ghats range situated in the Chittoor district of southern Andhra Pradesh. Tirumala hills, which is a part of the Tirupati hills, lie about 1,000 m above sea level and the study was carried out in the dry deciduous forests located between the Kalyan dam and Bhakrapet village. These areas have been declared as the Sri Venkateswara Wildlife Sanctuary by the Andhra Pradesh State Forest Department. A portion of the Tirumala Hills comes within the Tirupati-Tirumala Devasthanam Forest. Most of the bulbuls were caught in the mixed forests of Tirumala hills which

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[1] Accepted October 1992.

[2] Bombay Natural History Society, Hornbill House, Dr. Salim Ali Chowk, Shaheed Bhagat Singh Road, Bombay-400 023, India.

comprise clear-felled areas with secondary thickets of bamboo and plantations. The forests at Bhakrapet are natural scrub.

This paper is based on information collected from 1123 live birds examined for moult between June and November 1989. Birds were trapped in mist nets and were ringed, measured, weighed and examined for moult. In this paper the term 'juvenile' refers to a bird hatched out in the same breeding season (generally one month to four months old), and is separated from the adult by their morphological characters.

The primaries and secondaries as well as the rectrices (12 in number) were examined for moult. Primary feathers were numbered from distal (1) to proximal (10) including the much reduced distal first primary making a total of ten primaries, and eight secondaries were also similarly numbered. The moult was recorded on a separate moult card for each capture. Each primary and secondary feather was given a score of from "0" (old feathers) to "5" (full grown new feathers). The British Trust for Ornithology notation was adopted (Snow 1967) score "1" being a feather missing or in pin and "2", "3", "4" feathers one third, two thirds and nearly full grown respectively. The scores for all the 18 primaries and secondaries of one wing were then summed to give a maximum score 90 (50 for primaries and 40 for secondaries). A maximum score of 60 for the 12 rectrices was obtained in the same way. The body moult was recorded as "0" for no moult "S" slight moult, "A" and "C" for active and completed moult. The stages of the brood-patch was also recorded to relate the general moult to the breeding period.

Moult scores of different individuals were plotted against the dates of capture to estimate the duration, starting and finishing dates of moult. The slope determines the rate of moulting and the width, the spread in starting dates between individuals, as the moult score increases linearly with the time. Moult duration was also calculated from the rate of feather growth of individuals caught more than once during the moult. The relationship between primary and secondary scores is established by linear regression analysis (Fig. 2.).

RESULTS

Feather replacement: Feather replacement follows the passerine sequence of descendant moult. The primary moult starts from the innermost primary and progresses outwardly. Moult is normally symmetrical in both wings. Though secondary and tail moult start after the commencement of primary moult they span the remaining period of the primary moult. Secondary moult initially starts from the first feather and later from the middle feathers and progresses in both the ways. Tail moult starts from the central feathers and the progress is outwards in Redvented and Redwhiskered. While in Whitebrowed it is not so regular and asymmetric moult is not uncommon.

Commencement of moult: Moult starts earliest in Whitebrowed as 30% of the birds examined in June had already commenced their primary moult. In Redvented, one out of 23 adults, commenced its moult in the last week of June and a single juvenile caught was also observed in moult at that time. Though post nuptial moult was noticed in very few individuals of Redwhiskered from the third week of July, the majority of the adult birds commenced their moult in third week of August or later and the stray juveniles caught (3 in June and 1 in July) had commenced their post juvenile moult in the last week of June. By August 45% of juveniles were in primary moult (Figs. 1 & 2).

Number of feathers growing concurrently: The number of primary, secondary and tail feathers growing concurrently for the bulbuls is given in Table 1. Up to five primaries concurrently growing are recorded only twice in Redwhiskered. Thirty percent of the Redwhiskered, 21% of Whitebrowed and 15% of Redvented were observed with three primaries growing concurrently. The commonest situation in all the three species was for these to be two feathers growing simultaneously; the next commonest being three feathers in Whitebrowed and Redwhiskered and only one in Redvented. The

Table 1

NUMBER OF FEATHERS GROWING IN RELATION TO MOULT SCORE

Primary Score	No. of Primaries growing concurrently						Secondary score	No. of Secondaries growing concurrently							Tail score	No. of Tail feathers growing concurrently												
	0	1	2	3	4	5		0	1	2	3	4	5	6		0	1	2	3	4	5	6	7	8	9	10	11	12
1-10	WB 0	14	16	11	0	0	1-10	17	14	10	8	2	1	0	1-0	11	12	16	6	0	0	0	0	0	0	0	0	0
	RW 2	7	15	14	2	0		15	43	39	20	7	0	0		4	10	56	13	4	0	0	0	0	0	0	0	0
	RV 6	5	9	2	0	0		8	18	8	6	2	0	0		3	3	22	4	5	0	0	0	1	0	0	0	0
11-20	0	17	20	8	1	0	11-20	13	21	25	4	1	0	0	11-20	0	4	6	5	3	1	0	0	0	0	0	0	0
	2	15	68	20	4	2		4	23	51	26	8	3	0		6	2	1	0	17	4	6	1	4	0	1	0	0
	3	17	17	4	2	0		1	12	11	12	1	0	0		2	0	3	2	8	1	2	1	1	0	0	0	0
21-30	3	13	21	7	0	0	21-30	5	8	13	2	1	0	0	21-30	1	1	2	1	3	2	9	1	4	3	0	0	0
	0	19	76	30	0	0		5	11	44	19	4	12	1		0	1	1	0	3	0	2	1	8	7	3	2	4
	1	8	29	3	0	0		1	15	15	3	0	2	0		0	1	0	1	2	2	1	2	3	1	3	0	0
31-40	0	8	6	4	0	0	31-40	0	5	6	1	0	0	0	31-40	1	0	2	2	0	2	5	0	4	0	1	0	1
	0	3	27	54	4	0		0	17	26	14	1	1	0		0	1	0	1	0	1	2	0	7	13	13	3	3
	1	4	14	4	0	0		0	16	14	2	0	0	0		1	0	0	0	0	2	1	1	3	0	1	0	0
41-50	0	3	9	5	2	0									41-50	0	0	4	1	1	0	1	5	1	1	1	0	0
	0	9	21	34	11	0										0	0	1	0	0	1	3	1	13	3	10	0	1
	0	12	13	12	3	0										2	0	0	0	0	2	1	1	3	0	1	0	0
															51-60	0	6	7	2	6	0	2	0	0	0	0	0	0
																0	3	10	2	9	4	9	1	18	3	0	0	0
																1	1	2	1	5	1	2	0	5	0	0	0	0

NOTE: WB — Whitebrowed, RW — Redwhiskered, RV — Redvented.

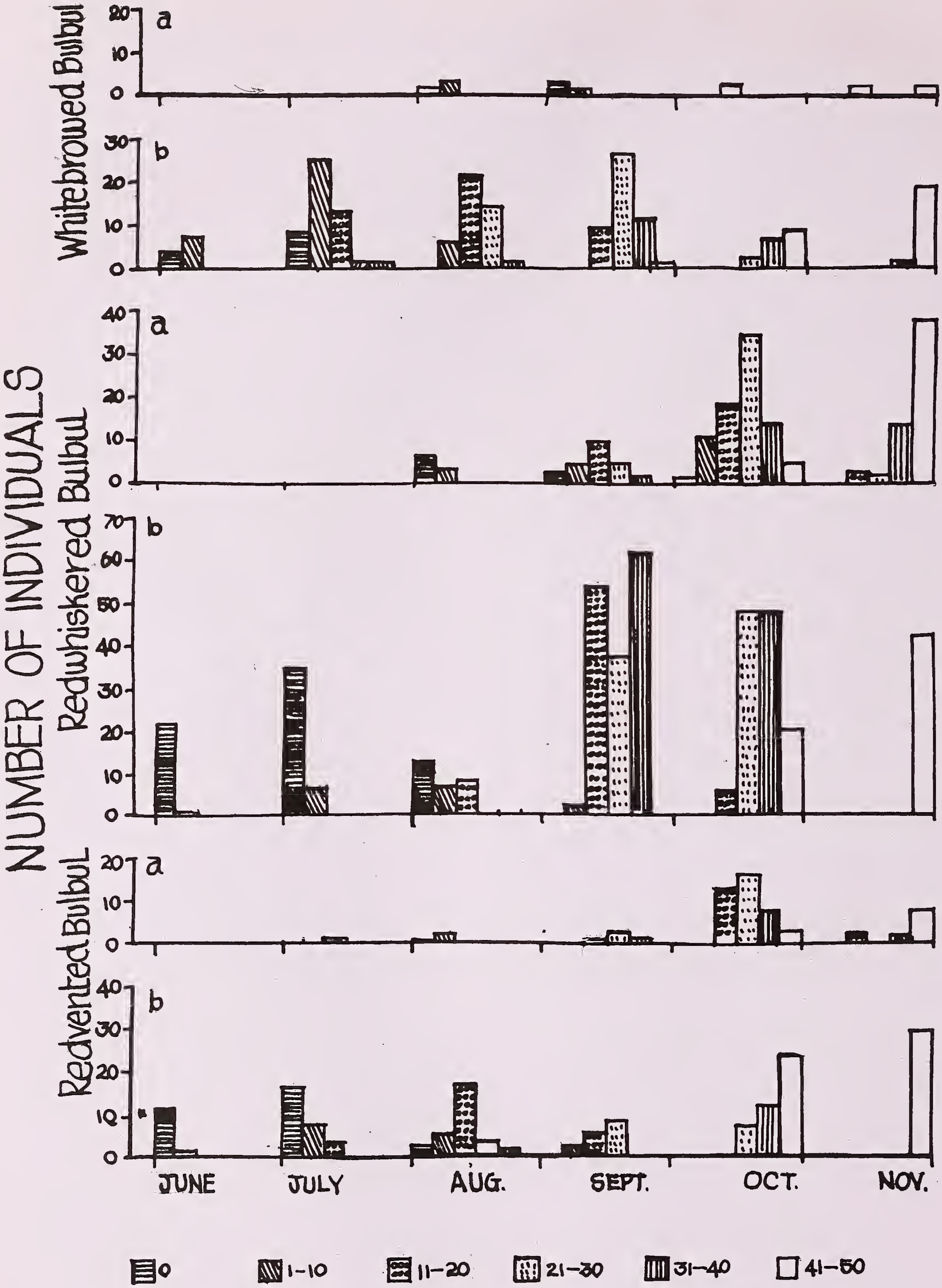

Fig. 1. Progress of primary moult in bulbuls. a) Juveniles; b) Adults.

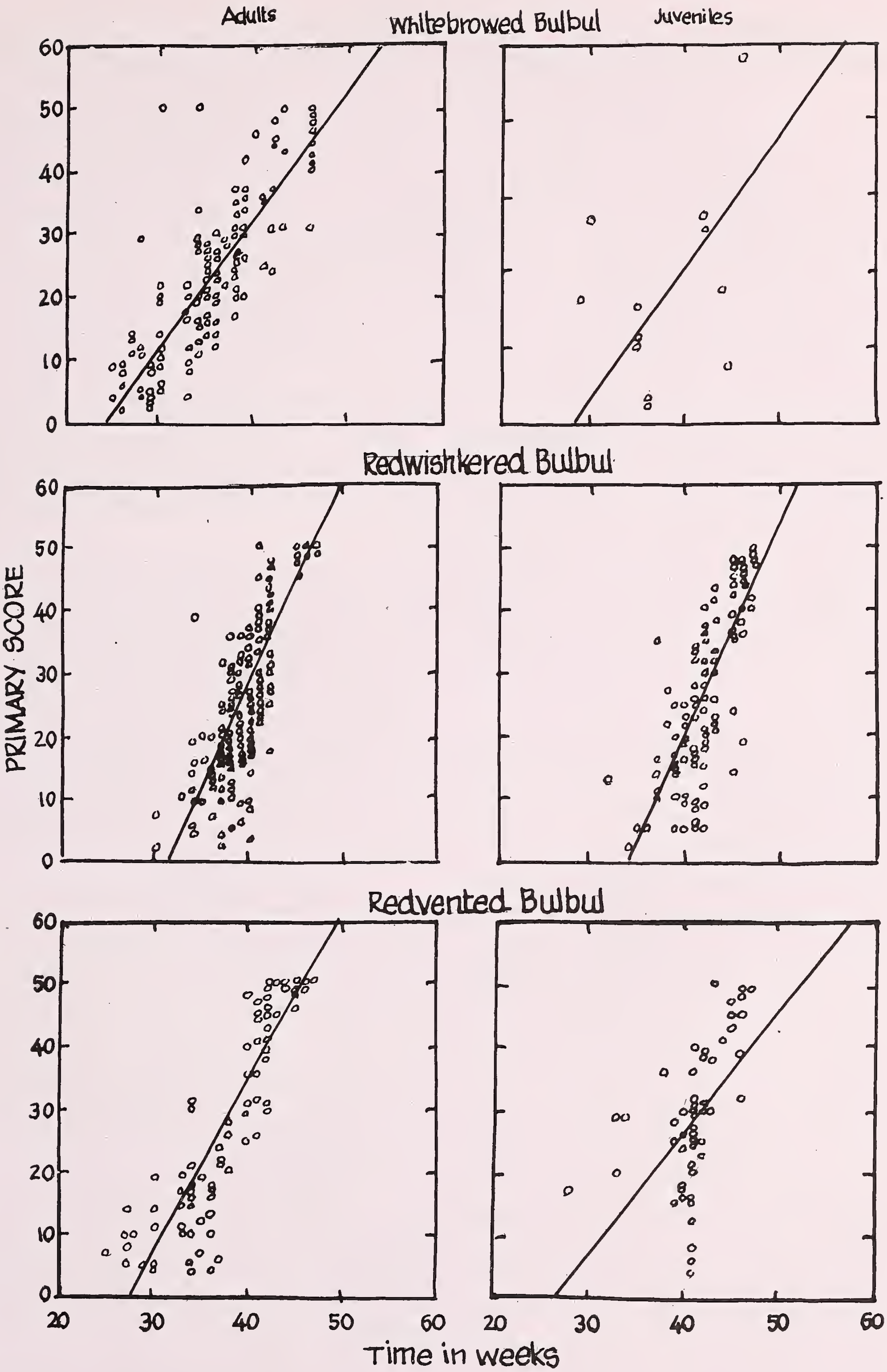

Fig. 2. Timing of primary moult in bulbuls. (Weeks are numbered from 1st week of January).

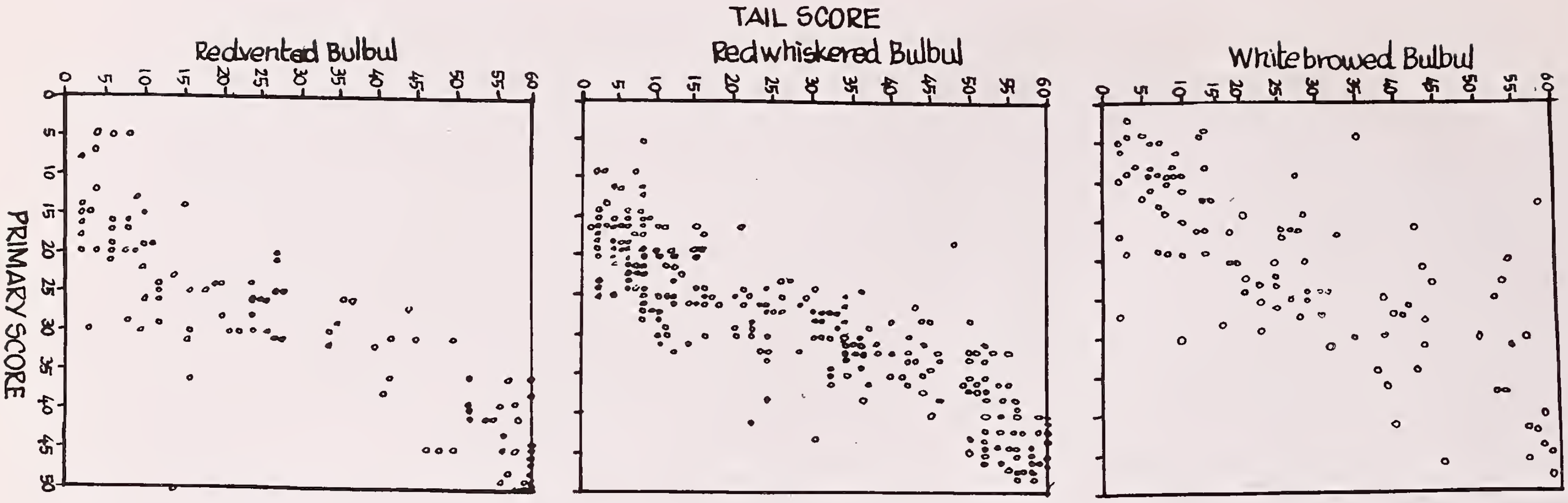

Fig. 3. Relation between primary and tail score in bulbuls.

highest number of concurrently growing primaries was observed in birds with primary moult scores of 41-45.

In Redwhiskered, individuals most commonly had three moulting secondaries, while in Redvented and Whitebrowed most individuals were recorded with two and one moulting secondary respectively. One individual of Redwhiskered had six secondaries growing concurrently.

Number of tail feathers growing concurrently varied from 2-12. In all the three species, two feathers growing concurrently was the commonest pattern.

Arrested or suspended moult: In arrested moult one or more feathers attain complete growth before the next feathers are dropped. Arrested moult was noticed in 6.5% of Redvented, 1.8% of Whitebrowed and 0.9% of Redwhiskered.

Moult duration: As individuals of Redvented and Redwhiskered were caught before commencement and just after completion of moult, the duration of moult could be recorded. Effective commencement of moult for Redwhiskered is mid-August and finishing time is third week of November. In the case of Redvented the starting and finishing time is mid July and the end of October (Fig. 2). Thus the approximate duration for Redwhiskered is 13 weeks and for Redvented 14 weeks. But most of the individuals of Whitebrowed commenced the moult in mid-June and completed in early November indicating a moult of approximately 18 weeks. In Redwhiskered four adults were caught twice during the moult and the rate of feather, replcement between the two captures was observed.

Post-juvenile moult is rapid for Redwhiskered and in general this species moults from the third week of September to the third week of November (9 weeks). The duration calculated for the two retrapped birds is 50 and 67 days respectively. While in Redvented the duration of post juvenile moult is almost the same as in Redwhiskered but commences one month earlier. For Whitebrowed the post-juvenile moult duration was not calculated as the sample size was too small.

Relation between primary and other moults: In none of the three species any secondaries moulted before commencement of primary moult. Secondary moult generally started when the primary score was 10-15 (Figs. 2 & 4). A few exceptions were noticed. Tail moult also commenced after the primary moult had started (Fig. 3). The secondary and tail moult are mostly completed at the same time as primary moult.

Slight body moult was noticed at the beginning of primary moult, but was most active when the primary moult score was between 30-40, and was usually completed at the same time as primary moult.

Breeding and moult: The first fledgling of Whitebrowed was sighted on 2nd June. Redvented was seen incubating eggs on 21st May and nestlings were seen up to 22nd August. Whitebrowed is the earliest breeder among the three species, breeding was completed by July and all the adults caught in August were in moult. Redwhiskered and Redvented completed their breeding by August and all adults caught in September were with moulting primaries.

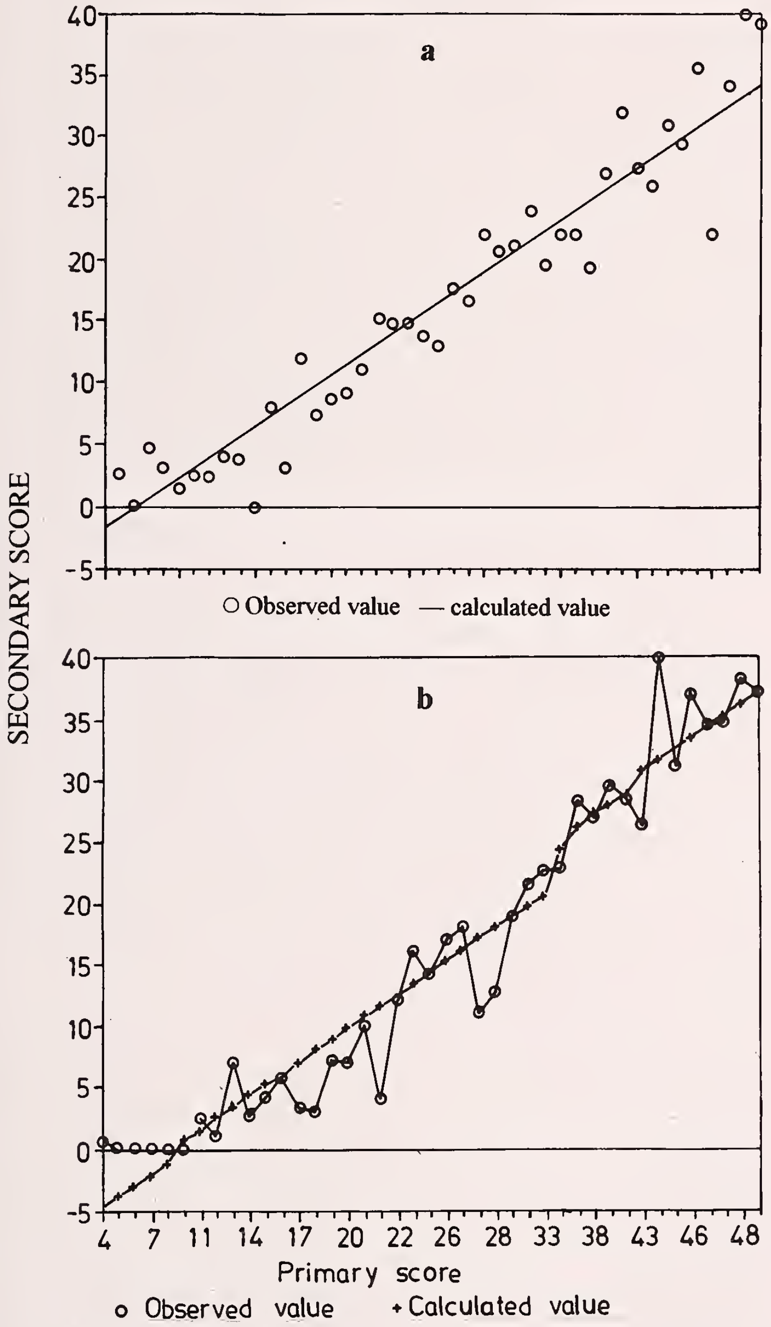

Fig. 4. Relation between primary and secondary score in bulbuls. (a) Whitebrowed; (b) Redvented.

Juveniles of all three species started their moult about one month after fledging, which is evident from the recapture of a juvenile Redvented on 10th October. During its first capture on 4th September the moult score was "0". After 36 days the score was just "6" with three innermost feathers in growth. To reach score "6" it might have taken less than eight days as the post-juvenile moult duration is just 8-9 weeks. The unmoulted adults noticed in August were still attending the nest.

Discussion

There is a distinct moulting period for each of the three bulbuls, this lasts from June to November. Adults of the three species undergo a complete moult soon after breeding is over. Similarly all the juveniles go through a complete moult, starting about one month after fledging. The pattern of post-juvenile moult is generally similar to post nuptial moult except in timing and duration. Late starting in post-juvenile moult compensated by the short duration, so that the end of moult is synchronized with the end of the post-nuptial moult of adults. Estimated duration indicates that Whitebrowed has a longer duration (18 weeks) than the other two species (Redvented and Redwhiskered 14 and 13 weeks respectively).

The moult duration is related to the rate of growth of individual feathers and the number of feathers growing concurrently. The maximum number of feathers concurrently growing occurred in Redwhiskered which had the shortest moult duration. However, Pienkowski and Knight (1976) stated that in waders of the Moroccan Coast, any interspecific variation in moulting rate was largely due to differences in the growth rates of the primaries, and not to differences in the number of primaries concurrently in growth.

Fogden (1972) reported that both in passerines and non-passerines, juveniles undergo a complete moult soon after fledging, which is generally similar to the post-nuptial moult of adults in its timing and duration. However, Snow (1967), found that the species moulting in temperate countries such as Britain, the juveniles of most species do not moult their remiges and rectrices after fledging. Our findings concur with Fogden's (1972) findings in Sarawak, except juveniles moult the tail; post-juvenile moult starts later than the post-nuptial moult and has a shorter duration.

Fogden (1972) also suggested that generally late moulting birds moult at a faster rate than those that begin early, and so finish at the same time. This is true in the three species of bulbuls studied. The late moulting Redwhiskered has shorter duration than the other two species which commence earlier. Similarly Redwhiskered and Redvented have shorter duration of post-juvenile moult than post-breeding moult as they commence their moult one month later than the adult. Fogden (1972) also estimated the duration of all the *Pycnonotus* sp. at Sarawak as 17 weeks which differs from our study. Price (1979) in his study of the breeding species of Lammasinghi of the Eastern Ghat range, mentioned that by July most of the birds have completed breeding and the adults undergo a complete post-nuptial moult which is completed by October. The complete post-juvenile moult was observed only in Redwhiskered and Redvented bulbuls, and also in the Redfronted Babbler *Stachyris rufifrons*. He observed that all the Redwhiskered caught from July 20 to 1st August were in primary moult which is contrary to our study. Of the 31 individuals only three were seen with primary moult during the corresponding period in the Tirupati Hills.

Moult and breeding do not overlap as the moult starts after breeding. When moult starts the broodpatch is either with scales or with calami to cover up the broodpatch, indicating the end of the brooding period. However, the possibility of moulting during the nestling period cannot be ruled out completely. The moult of wing and tail in the adults of five species of bulbul from Mopeia (Mozambique) and Nchalo (Malawi) occurred between December and July and immature birds start moulting when they are about three months old (Hanmer 1977). This timing is earlier than the timing of moult in bulbuls of Tirupati Hills where the young start moulting one month after fledging.

Food abundance may be one of the major factors determining the timing of the moult, and at Tirupati the fruiting season of *Zizyphus oenoplia* and *Scutia* sp., which are the favourite food of the bulbuls, coincides with the moult. Other trees in fruit were *Santalum* sp. and *Syzygium cumini* which were preferred by Redvented and Redwhiskered. During the fruiting season of the above trees (September and October), there was a heavy influx of Redwhiskered and Redvented mostly to the Tirumala hills which resulted in a higher catches of these two species at this time. Vertical and horizontal movements in bulbuls at Lammasinghi was reported by Price (1979) who ascribed the low rate of recapture to such movements. The percentage of recapture of the bulbuls at Tirupati hills was also very low probably indicating dispersal immediately after breeding. In comparison, more fledglings of Redvented were sighted than of the other two species, which may be due to the higher breeding success of Redvented than Redwhiskered and Whitebrowed or to less movement out of the area.

Miller (in Fogden 1972) suggested that in tropical America the resident birds breed and moult during the part of the year when the northern migrants are absent, which implies competition between the resident and migrant species. At Tirupathi hills the residents complete their breeding before the arrival of the migrants but extend the moult till November when the migrants are present.

ACKNOWLEDGEMENTS

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FLORA OF PUNJAB STATE — A PHYTOGEOGRAPHIC ASSESSMENT[1]

M. SHARMA AND KUSUM RAJPAL[2]

(With a text-figure)

Key words: phytogeography, flora, Punjab

A phytogeographic analysis has been made of 1,119 spermatophytes recorded from Punjab State (India). The floral elements of its two well-marked floristic subunits have been compared and possible reasons given for the distribution of floral elements. Four broad classes of floral elements have been distinguished. The Indian element is rather poor. The eastern element almost equals the western element which shows that the area is a meeting ground for these two types of elements. The general element is the most conspicuous and includes species of cosmopolitan, tropical and temperate distribution. The State is categorized as a transition zone from the warm and high seasonal rainfall tropical areas of South-East Asia to the semi-arid Middle Eastern countries characterized by colder winter and absence of any monsoon influence.

INTRODUCTION

With the aim of writing an up-to-date flora of Punjab State (India), the senior author has been engaged uninterruptedly in its floristic survey eversince July 1963. Bibliographic reference to sixtythree publications that ensued will be found in Sharma (1990). Hitherto, no phytogeographic studies have been made on the flora of Punjab State. The present paper covers this aspect and also makes a comparison of the floral elements of its two well-marked floristic subunits, namely semi-arid Punjab and Punjab Shivaliks vis-a-vis the whole of Punjab State.

GENERAL FEATURES OF THE AREA

The present Punjab State (India) lies between 29° 30' and 32° 32' N lat. and 73°54' and 76°50' E long. and covers an area of 50,362 sq.km (Fig. 1). Within it; three floristic subunits, namely (1) semi-arid Punjab (mainly southern part), (2) moister plain country (central part) and (3) Shivaliks (north-eastern hilly tract) can be recognized. The first and third subunits are not only two disjunct zones but also show difference in topography and climate and are characterized by their distinctive floral elements. The intermediate moister plain country, on the other hand, has a mixed or the general flora of the State. Height above m.s.l. of the three zones respectively varies between 205-230m, 230-300 m and 300-800 m; whereas average annual rainfall is 43 cm, 60 cm and 90 cm in corresponding tracts. The winters are intensely cold and summers extremely hot. The

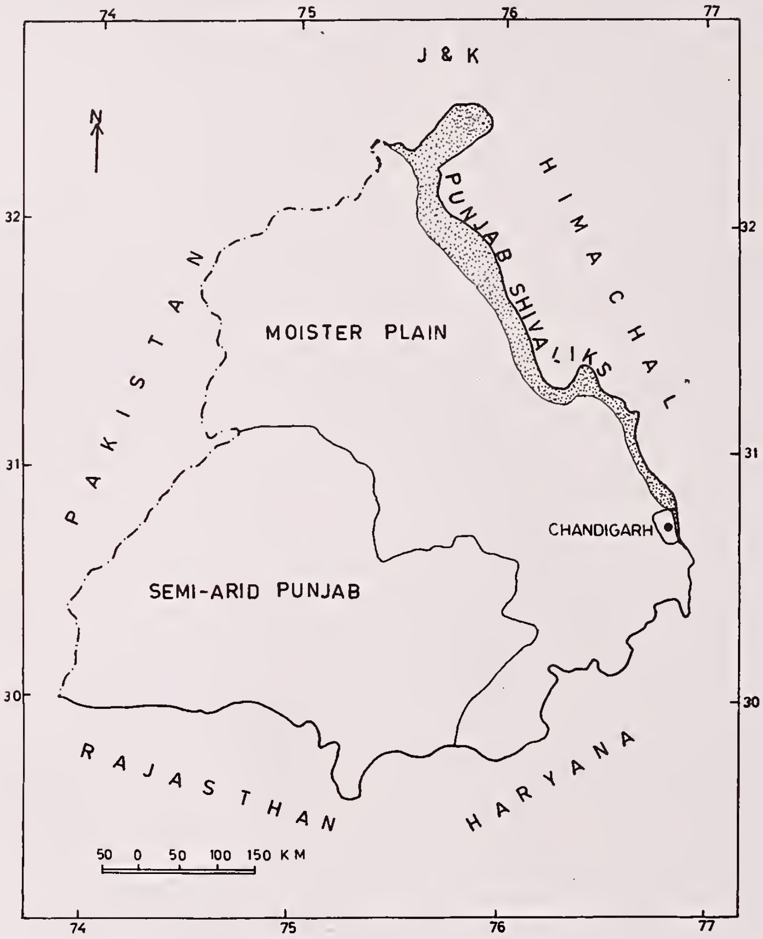

Fig. 1. Sketch map of Punjab State (India) showing its floristic subunits.

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[1] Accepted January 1991.

[2] Department of Botany, Punjabi University, Patiala-147 002, India.

minimum temperature (-2.8°C) was recorded at Amritsar on 24th January 1989 and maximum (49°C) at Bathinda on 26-28th May 1984.

MATERIAL AND METHODS

Based upon the plant collections made by the present senior writer for nearly 25 years (1963-1987) from Punjab State, study of pertinent herbarium specimens at BSD, DD, PAN and PUN, and the relevant information scattered in literature; a check-list of the vascular plants of Punjab (Sharma 1990) was published. The list includes 1,879 species out of which 1,119 wild and naturalized spermatophytes have been taken into account and form the basis for the present communication. To avoid cumbersome terminology of several authors in which the areas of distribution may have somewhat different connotations, the regions as presently recognized are practically the same as listed by Bharucha and Meher-Homji (1965). The possible route(s) and means of migration have been discussed and illustrated in detail by Chatterjee (1939, 1947), Maheshwari (1962, 1979) and Singh (1978). The observations by these authors are equally applicable to the floral elements of Punjab also and hence these two aspects have been excluded from the purview of discussion.

RESULTS

The analysis of major phytogeographic regions of the flora of Punjab State is given in Table 1. The floral elements of these regions have been broadly grouped into 4 main classes (Table 2) taking into account the fact that it is not always possible to assign a species precisely to one group or the other particularly in those cases where the species are widely separated. A generalized view has been taken in such cases. Comparative analysis of the floral element classes of the different floristic subunits of Punjab State has been given in Table 3.

DISCUSSION

The flora of Punjab State shows four distinguishable patterns. These patterns (type of elements) have been shaped by the coincidence of historical events, topography, climate and substratum. More recently, however, anthropogenic disturbances have altered these patterns to some extent. The discussion below pertains to the floral elements of the four main classes as grouped in Table 2 and compared in Table 3.

TABLE 1

ANALYSIS OF MAJOR PHYTOGEOGRAPHIC REGIONS OF THE FLORA OF PUNJAB STATE

No.	Region	No. of Species	Percentage
1.	Endemic	3	0.27
2.	India	83	7.42
3.	Indo - Malaya	263	23.51
4.	North Africa-Indian Desert (Saharo-Sindian)	106	9.47
5.	Tropical and North African-Indian Desert (Sudano-Deccanian)	50	4.47
6.	Tropical Africa - India	43	3.84
7.	Tropics of the Old World	209	18.68
8.	Pantropical	114	10.19
9.	Warm countries	13	1.16
10.	Subtropical and temperate	7	0.62
11.	Mediterranean	22	1.97
12.	Orient	11	0.98
13.	Europe	62	5.54
14.	Cosmopolitan	30	2.68
15.	Americas	53	4.73
16.	Himalaya	31	2.77
17.	Temperate	19	1.70
	Total	1119	100.00

The Indian element: It is rather poorly represented in all the three floral regions (Table 3). The extreme climatic conditions and dry, sandy substratum appear to be the barriers to the establishment of the Indian element. Chatterjee (1939) has listed 134 dicot genera endemic to India. Out of these; only few like *Ougeinia* Benth., *Butea* Willd., *Caesulia* Roxb., *Glossocardia* Cass. and *Aechmanthera* Nees occur in Punjab. There are only three endemic species in the flora of Punjab State, namely *Hibiscus hoshiarpurensis* Paul and Nayar, *Argyrolobium album* Bhattacharyya and *Rumex punjabensis* Vaid and Naithani. The first two of these have been reported from Punjab Shivaliks. There is no endemic species in the flora of semi-arid Punjab. It is interesting to note that Indian

TABLE 2

ANALYSIS OF THE FLORAL ELEMENT CLASSES OF THE FLORA OF PUNJAB STATE

No.	Floral element	No. of Species	%
1.	Indian	117	10.46
	(a) Endemic (1)*		
	(b) Indian (2)*		
	(c) Himalayan (16)*		
2.	Eastern (3)* (Indo-Malayan)	263	23.51
3.	Western	294	26.27
	(a) N. African-Indian Desert (4)* (Saharo-Sindian)		
	(b) Tropical and N. African-Indian Desert (5)* (Sudano-Deccanian)		
	(c) Tropical African - Indian (6)*		
	(d) Mediterranean - Oriental-European (11, 12, 13)*		
4.	General	445	39.76
	(a) Tropical (7, 8, 10, 15)*		
	(b) Warm countries (9)*		
	(c) Temperate (17)*		
	(d) Cosmopolitan (14)*		
	Total	1119	100.00

* Numbers within parentheses correspond to the No. of Table 1.

element preponderates in the semi-arid Punjab in comparison to the flora of Punjab Shivaliks. The Himalayan element is almost totally lacking from the semi-arid Punjab. *Saussurea heteromalla* Hand.-Mazz. has been recorded from this tract which appears to be a chance introduction because only two specimens have been gathered from this area. The absence of the Himalayan element from the semi-arid Punjab can be easily explained because of the discontinuity of Punjab Shivaliks with this zone, besides the difference in the edapho-climatic features of the two areas.

The Eastern element: The percentage of Eastern or Indo-Malayan element is nearly double than that of Indian element. These species are the denizens of humid climate and their occurrence is as high as 53% in a humid region like that of Bengal (Agharkar and Ghose 1931). These cannot tolerate the dry and semi-arid conditions as prevailing in our area. A study of the floral elements in relation to climate reveals that as there is an increase in the rainfall and decrease in temperature from south towards north Punjab, there is a marked increase in the number of eastern element. This is proved by the fact that the eastern element constitutes only 12.42% of the flora of semi-arid Punjab, whereas it contributes 28.83% in the flora of Punjab Shivaliks where the climatic conditions are somewhat moderate in comparison to those of semi-arid Punjab. Conversely, the western element (cf. Table 3) is much pronounced in the southern side (semi-arid Punjab) than in Shivaliks. The present studies fully support the conclusion arrived at by Legris and Meher-Homji (1968) that the Indo-Malayan and the Indian elements are represented a little in the dry,

TABLE 3

COMPARATIVE ANALYSIS OF THE FLORAL ELEMENT CLASSES OF THE DIFFERENT FLORISTIC REGIONS/ SUBUNITS OF PUNJAB STATE

	Floral element	Punjab State (present work)		Punjab Shivaliks (present work)		Semi-arid Punjab (Sharma et al. 1987)	
		No. of species	Percentage	No. of species	Percentage	No. of species	Percentage
1.	Indian	117	10.46	75	12.36	47	9.89
2.	Eastern	263	23.51	175	28.83	59	12.42
3.	Western	294	26.27	99	16.32	145	30.54
4.	General	445	39.76	258	42.49	224	47.15
	Total	1119	100.00	607	100.00	475	100.00

thorny series of *Capparis-Acacia* and *Salvadora - Prosopis* vegetation, so characteristic of semi-arid Punjab.

The Western element: It is fairly well represented in the flora of Punjab State. It comprises of the African and Mediterranean — Oriental-European species. The African element (67.68%) in the flora of Punjab State is much more than the rest of the element of this class. This is probably because of the similar climatic conditions in Africa and present area. The distribution of this element is governed by high temperature and comparatively low rainfall as experienced in Punjab State. Further, there is no effective barrier on the western boundary of India to check the migration of xerophytic elements of Afro-Arabian origin which may enter through Rajasthan or Pakistan. Mediterranean-Oriental-European element though not as plentiful as the African element yet is well represented (32.32%) in the flora of Punjab State. The low winter temperature prevailing in Punjab may account for the introduction of this element. The north-west India, according to Gaussen (1933), forms a part of the mediterranean region. Adventive taxa of western origin which have recently established themselves in Punjab include *Hypecoum pendulum* Linn., *Sagina apetala* Ard., *Oxalis pes-caprae* Linn., *Trifolium tomentosum* Linn., *Urtica urens* Linn., *Eriochloa nubica* Thell., *Lophochloa pumila* Bor, *Panicum maximum* Jacq., etc. According to Legris and Meher-Homji (1968) this element exceeds but little the limit of winter range and it does not penetrate deeply into the Indian peninsula.

The General element: It is by far the most conspicuous and includes, besides the cosmopolitan element, the temperate and tropical species also. The tropical element much exceeds the flora of any other type here. The temperate element is very poorly represented because of the inclusion of semi-arid tract in the area and extremely hot climate during summer and monsoon months. The cosmopolitan species are either naturalized from cultivation (*Brassica campestris* Linn. vars., *Raphanus sativus* Linn.) or are aquatic (including amphibious) in nature. Common ones among these in the area are *Bacopa monnieri* Penn., *Ceratophyllum demersum* Linn., *Eleocharis palustris* R. Br., *Lemna perpusilla* Torr., *Spirodela polyrhiza* Schleid., *Scirpus maritimus* Linn., *Veronica anagallis - aquatica* Linn. and *Zannichellia palustris* Linn. The wide distribution of aquatic plants is perhaps due to their dispersal by migratory birds. Besides, an aquatic habitat constitutes a most homogeneous medium. Other cosmopolitan species like *Chenopodium album* Linn., *C. murale* Linn., *Cleome viscosa* Linn., *Convolvulus arvensis* Linn., *Coronopus didymus* Linn., *Poa annua* Linn., *Setaria verticillata* P. Beauv., *Solanum nigrum* Linn., *Sonchus asper* Hill, *S. oleraceus* Linn., *Xanthium strumarium* Linn., etc. are aggressive weeds. Temperate element is very meagre and represented by 1.70% of the flora. This is to be expected because of the extremely hot climate in the area during summer and monsoon months.

The occurrence of so many types of floral elements in Punjab State or its subunits like Shivalik hills or semi-arid region is interesting. The area has a very dry type of climate with a long dry season of about 9-10 months alternating with a very short and erratic rainy season (July-September). Summers are very hot with the mean minimum and maximum temperatures during May-June being about 15°C and 43°C respectively. On the other extreme, winters are severe. The mean maximum and minimum temperatures during the colder months (December-January) are *c.* 20°C and *c.* 10°C respectively. Besides, there are also conspicuous alternations in the hours of the day length during summer and winter. The overlapping of several floral elements seems to be due to these seasonal changes in the climate. While the Indian element has practically the same percentage in Punjab State, Punjab Shivaliks and semi-arid Punjab, the proportion of Indo-Malayan element is more than double in the flora of Punjab Shivaliks in comparison to the flora of semi-arid Punjab. This is because the Indo-Malayan element generally develops during monsoon period and seeks shelter in humid sites. Such conditions are more pronounced in the Shivalik hills. Tropical type of climate accommodates a very high percentage (35.38%) of species and includes the elements of tropical, subtropical and warm countries. Similarly dry and hot conditions favour the African element extending into the Indian desert in particular or sometimes going beyond it. This can be appreciated by the fact that the percentage of this flora is as high as 13.90% in semi-arid Punjab out of 17.78% of the total African flora of Punjab State. The fairly good representation of temperate and Mediterranean-Oriental-European elements (10.19%) is because of the cold winter period which permits its penetration into the area. The typical New World element is extremely poor and constitutes only 4.73% of the total flora. The majority of these American species like *Alternanthera tenella* Colla, *A.paronychioides* St.-Hil., *Argemone mexicana* Linn., *A.ochroleuca* Sweet, *Croton bonplandianum* Baill., *Eichhornia crassipes* Solms, *Erigeron bonariensis* Linn., *Gnaphalium pensylvanicum* Willd., *Gomphrena celosioides* Mart., *Hyptis suaveolens* Poit., *Ipomoea carnea* Jacq. subsp. *fistulosa* D. Austin, *Opuntia dillenii* Haw., *O. stricta* Haw., *Oxalis corymbosa* DC., *O. dehradunensis* Raizada, *Parthenium hysterophorus* Linn., *Physalis angulata* Linn., *Portulaca pilosa* Linn., *Prosopis chilensis* DC. and *Verbesina encelioides* A. Gray have established themselves very well probably because of the similar climatic conditions prevailing in their native areas and new homes. The Western element (26.27%) slightly exceeds the Eastern element (23.51%) in the flora of Punjab State. This shows that the area is a meeting place of the Eastern and Western elements.

From the perspective of Punjab flora, the State must be categorized largely as a transition zone from the warm and high seasonal rainfall of tropical areas which characterize most countries in south-east Asia (eastern element) to the semi-arid Middle-Eastern countries with colder winter and absence of any monsoon influence or marked rainy season.

It may be concluded that as the area became denuded, the original species had to compete with the introduced ones. The exotic species; due to their aggressive nature, suitable climate and probably disease free environment in their new homes, have been able to colonise the exposed areas and often displace the previously established species of Indian subcontinent. In this connection, a relatively recent case of *Parthenium hysterophorus* Linn. needs to be quoted. This New World species was recorded from Punjab just over a decade ago (Sharma 1979). During this short period it has assumed the dimensions of an obnoxious and gregarious weed. It has colonized various areas throughout the State replacing the already thriving plant species from waste places along roadsides and railway tracks. Thus the introduction of the alien plants had a harmful influence on the native vegetation. Consequently, as the settlement advanced the flora began to assume a mixed character.

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BUTTERFLY POLLINATION OF *CLERODENDRUM INFORTUNATUM* (VERBENACEAE)[1]

T. Byragi Reddy and C. Subba Reddi[2]

(With two text-figures)

Key words: *Clerodendrum infortunatum,* butterflies, *Papilio polytes, P. polymnestor, Atrophaneura hector,* pollination

Clerodendrum infortunatum L. flowers from February to April. The flowers anthese during 0600-0700 hr and offer nectar and pollen to insect visitors. Nectar is secreted up to the evening of 3rd day. The nectar sugars are sucrose, glucose and fructose. Sucrose is predominant. Sugar concentration ranges from 6 to 30%. Protein and amino acids are present. The breeding system incorporates both geitonogamy and xenogamy. A total of 17 species of insects are found foraging at the flowers diurnally. Male and female phases of the flowers are separated in time and space. The Papilionoid butterflies (*Papilio polytes, P. polymnestor* and *Atrophaneura hector*) approached the flower horizontally, grasped it with their legs and continuously fluttered as they probed for nectar. The wings stroke the anthers/stigma, thereby causing pterigotribic pollination.

INTRODUCTION

On the basis of observations on wood-white butterfly (*Leptidea sinapis*) and its nectar plants, *Viola canina, V. riviniana* and *Lathyrus montanus;* Wiklund *et al.* 1979 hypothesised that butterflies as a group may have evolved to a parasitic mode of life as adults, feeding on the nectar of flowers without pollinating them. However there are certain authentic cases of butterfly pollination *Caesalpinia pulcherrima,* Cruden and Hermann-Parker 1979; *Asclepia syriaca,* Percival 1965; *Aesculus californica,* Moldenke 1976; *Platanthera ciliaris,* Smith and Snow 1976; *Phlox* species, Grant and Grant 1965, Levin and Berube 1972; *Anquria,* Gilbert 1975; *Cnidoscolus urens,* Bawa *et al.* 1983; *Gossypium* species and *Hibiscus esculentus,* Pajni and Sukhwinder Kaur 1979, which does not agree the hypothesis of Wiklund *et al.* 1979.

To shed more light on this aspect, an attempt was made to study the role of butterflies in the pollination of *Clerodendrum infortunatum,* at Visakhapatnam, a coastal city of India.

MATERIAL AND METHODS

Observations were made during 1986 and 1987 on the natural populations of *C. infortunatum* L. (Verbenaceae) occurring in Andhra University Campus, Visakhapatnam (17° 42' N, 82° 18' E). Pollen output per anther was assessed by counting all the pollen grains in a sample obtained by gently crushing and tapping the anther on a clean microscope slide, spreading the pollen mass uniformly. The longevity of pollen and stigma was assessed based on the fruit set success from hand-pollination at regular intervals. Pollen loads on stigmas were counted during the female phase. The flowers to be hand-pollinated were emasculated in the bud condition. Tests for apomixis/autogamy, geitonogamy and xenogamy were conducted through controlled pollinations. Apomixis was tested by bagging the emasculated flowers free of pollen, augogamy by pollinating flowers with the pollen of the same flower, for geitonogamy with the pollen of different flowers of conspecific plant, for xenogamy with the pollen of a different conspecific plant.

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[1] Accepted February 1995.

[2] Department of Environmental Sciences, Andhra University, Waltair-530003.

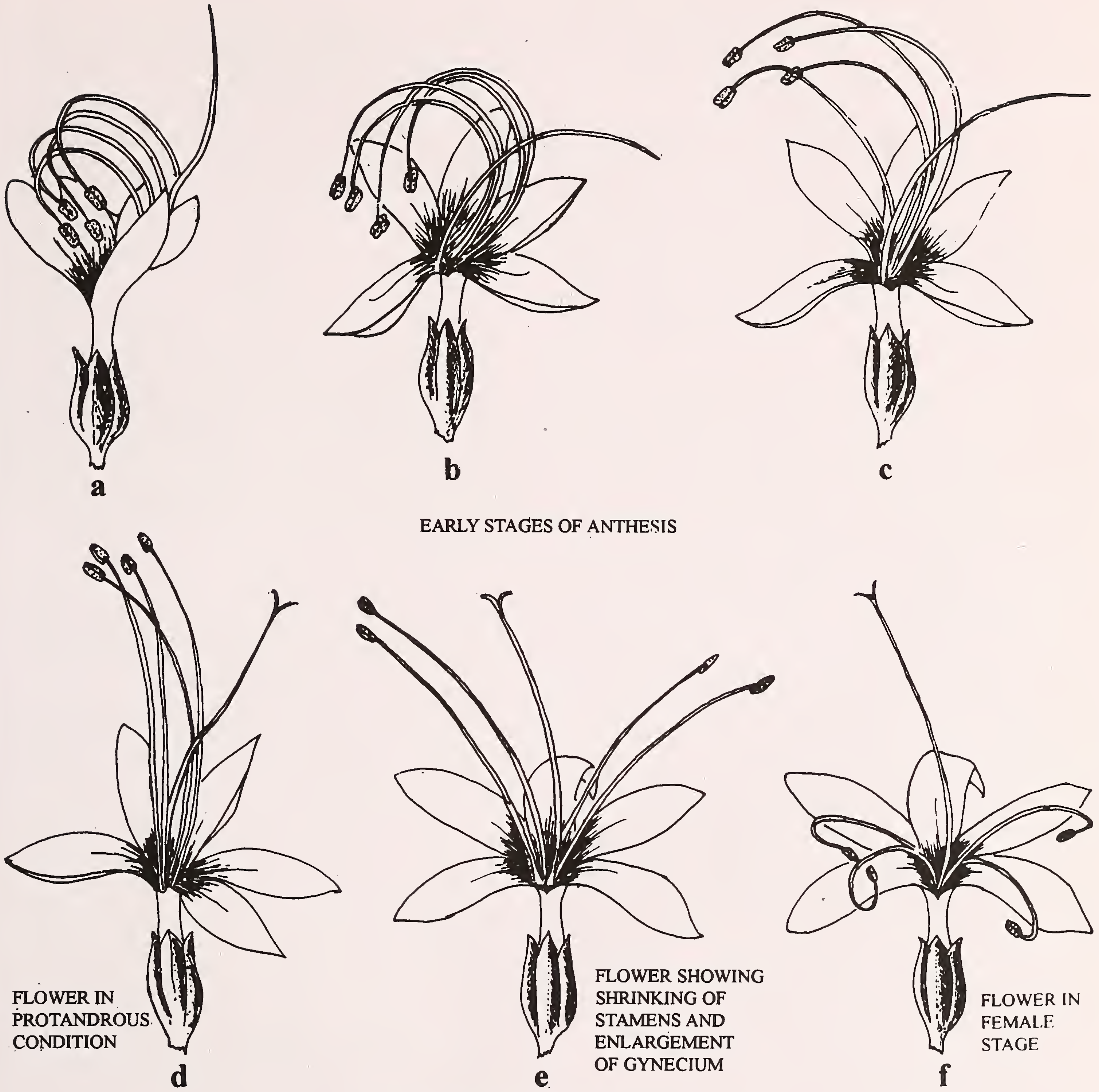
a
b
c
EARLY STAGES OF ANTHESIS
FLOWER IN PROTANDROUS CONDITION
d
FLOWER SHOWING SHRINKING OF STAMENS AND ENLARGEMENT OF GYNECIUM
e
FLOWER IN FEMALE STAGE
f

Fig. 1. Different phases of *C. infortunatum* flower.

Nectar produced in flowers protected from insects for 3 hr period was measured using disposable micropipettes. Sugar concentrations were determined with a pocket refractometer and sugar composition was analysed by paper-chromatography and spectrophotometry (Horborne 1973). Proteins and amino acids were identified by the method of Baker and Baker (1973).

The butterflies caught over the flowers were identified with the help of Wynter-Blyth (1957) and the nomenclature used is after Varshney (1983). The behaviour of visitors, the length of a visit and flowers visited in a unit time, using a stop watch, were carefully studied. The more frequent visitors were caught and examined under a stereomicroscope for the pollen adhering to the body and then washed off with alcohol. The washings with a droplet of lactophenol aniline-blue were observed for pollen under a light microscope.

RESULTS

1. Blooming phenology: The plants begin to bloom soon after the cold season, the flowering season extending from February to April every year. Each branch terminates in a sub-corymbose panicle. The number of flowers per inflorescence ranges from 10-100. Flowering lasts for 5-32 days, depending on inflorescence size. The number of flowers that anthese daily varies from 1-15.

2. Phenology of anthesis: Anthesis begins at about 0500 hr with the protrusion of essential organs and is complete, when the petals unfold by 0600 hr. Pistil and stamens appear twisted and curled upward in bud condition (Fig. 1a). After flower opens they gradually become uncoiled (Fig. 1b, c). The stamens uncoil after the pistil. Between 0700 and 0900 hr stamens become linear and face the horizontal corolla tube, while the style with the closely pressed stigmatic lobes is bent down towards the lower lip (Fig. 1d). This is a functional male phase. By the evening of the same day stamens are bending sideways — two stamens to each side (Fig. 1e). On the second morning, anthers wither and stamens still bend sideways, the style straightens to occupy the position previously taken by the stamens (Fig. lf). The stigmatic lobes spread out to receive pollen and the flower is in a functionally female phase. By the 3rd evening, the corolla withers along with the style, stigma and staminal filaments. Sepals are persistent, and turn red after the fruit is formed.

3. Pollen Characters: Pollen grains are freed through longitudinal anther dehiscence when stamens become linear at about 0700 hr. They are of three sizes: large grains 68.2 µm, and medium 58.5 um and small 47.0 µm, spheroidal, deep violet in colour and exine spiny. Their output per anther ranges from 1400-2600 ($\bar{x}$ = 2000), out of which 63% are fertile. The fertile grains remained viable for 26 hr after anther dehiscence, as indicated by the fruit set on hand-pollination using stored pollen (Table 1). Pollen-ovule ratio is 2000:1.

TABLE 1

LONGEVITY OF POLLEN OF *C. infortunatum* ASSESSED THROUGH FRUIT SET CAPABILITY AFTER HAND-POLLINATIONS

Hours of pollen storage after anther dehiscence	No. of flowers pollinated	Fruit set (%)	Seed set (%)
12.00	25	72	98.85
24.00	25	52	55.00
26.00	25	28	38.00
28.00	25	0	00.00

4. **Stigma receptivity:** Stigma attained receptivity after 12 hr of anthesis (at 0700 hr) and continued to be so up to 35 hr of anthesis as assessed by fruit set on hand-pollination of the pistils (at similar stages of development) at different intervals (Table 2).

TABLE 2

LONGEVITY OF STIGMA OF *C. infortunatum* ASSESSED THROUGH FRUIT SET CAPABILITY AFTER HAND-POLLINATIONS

Hours of stigma life after maturity	No. of flowers pollinated	Fruit set (%)	Seed set (%)	Fecundity (%)
12.00	25	72	93.00	93.00
24.00	25	72	57.00	57.00
28.00	25	60	87.00	87.00
32.00	25	60	83.00	83.00
35.00	25	40	100.00	100.00
48.00	25	40	00.00	00.00

5. **Nectar dynamics:** Nectar volumes measured at 3 hr intervals indicated that the rate of production varies throughout flower life (Table 3). Secretion on the day of flower opening began in the hypogeal disc from 0630 hr and continued up to the 3rd evening. It was small in the forenoon, increased from noon and amounted to over 2 µl for a 3 hr period. Next morning the secretion was considerably reduced, and on the third day it was in traces. Sugar concentration was also low (6-12%) in the forenoon, but was maximum (20-30%) at 1300-1600 hr and then declined 14% by 1900 hr.

Table 3

NECTAR VOLUMES MEASURED AT 3-HOURLY INTERVALS IN *C. infortunatum*

Time (h)	Nectar volume R	(µl) $\bar{x}$	Sugar Concentration (%)	Temp. (°C)	RH (%)
0700 (anthesis)	0.87-1.00	0.93	06	25.0	82
1000	0.93-1.06	0.99	12	27.0	77
1300	2.00-2.40	2.18	30	29.0	65
1600	1.00-3.66	2.25	20	27.0	69
1900	1.47-2.60	2.12	14	26.5	75
Second day					
0700	0.32-0.50	0.41	12	25.5	80
1000	0.12-0.35	0.25	14	28.0	75
1300	0.10-0.20	0.15	17	29.6	69
1600	Traces				

On the second day, the volume was small (0.15-0.41 µl) and the concentrations were 12-17%.

Proteins and amino acids were present; the score on histidine scale was 6. The sugars present were sucrose, glucose and fructose, sucrose being dominant.

6. **Flower-visitor activity dynamics:** Altogether 17 species of insects foraged at the flowers (Table 4). Of these, three were bees and 14 Lepidoptera. The latter consisted of 13 butterfly species and one hawkmoth. Census at the initial, peak and final phases of the blooming season revealed that *Amegilla* among the bees, *Papilio polytes, Atrophaneura hector, Valeria valeria anais* and *Barbo cinnara* among the butterflies were consistent and made repeated visits at the two study sites, and in the two consecutive years of study. *Papilio polymnestor* was more frequent at Botany Garden site and sporadic at the V.P. Hall site. *Pelopidas mathias, Graphium agamemnon* were conspicuous at the V.P. Hall site in 1986. *Pseudapis oxybeloides* made repeated visits in 1987. *Ceratina* appeared in 1987 at V.P. Hall site only (Fig. 2).

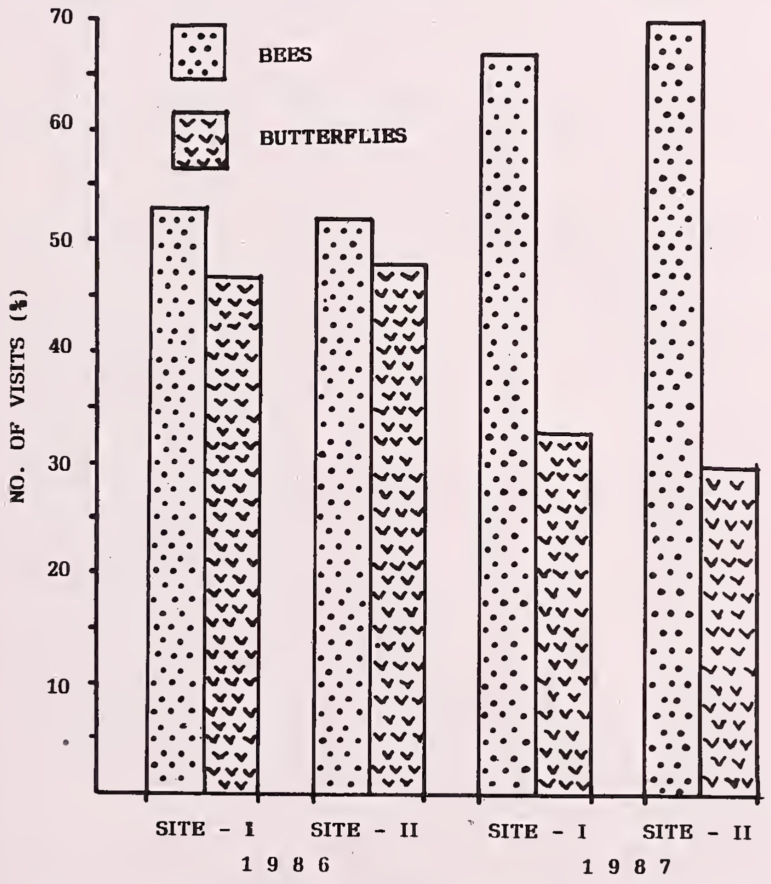

Fig. 2. Insect group abundance on *C. infortunatum* flowers at two study sites.

The bees exclusively collect pollen from these flowers. *Amegilla* collected pollen by touching the dehiscent anthers several times. It never alighted on the anther. It touched the dehiscent anther, then hovered and groomed pollen from the body, and then repeated the action. Other bees alighted on the anther and collected pollen.

The butterflies probed for nectar without any bias to the functional sex phase of the flower. The Papilionids approached the horizontally oriented flowers frontally, supported by their legs on the petals/staminal filaments/style, and took nectar while constantly fluttering their wings. The wings and body touch the essential flower parts. The

Table 4

CENSUS OF FLOWER VISITORS ON *C. infortunatum*

Insect species	BOTANY GARDEN SITE I						V. P. HALL SITE II					
	1986			1987			1986			1987		
	13/2	27/2	14/3	15/3	24/3	5/4	15/2	23/2	16/3	3/3	13/3	28/3
BEES												
Amegilla sp.	745	603	635	742	1,134	680	547	542	514	508	494	353
Ceratina sp.	0	0	0	0	0	0	0	0	0	86	71	72
Pseudapis oxybeloides	0	163	0	52	305	222	0	0	0	452	550	419
MOTH												
Macroglossum gyrans	0	0	0	0	171	0	0	123	0	0	0	0
BUTTERFLIES												
Euploea core	0	0	24	0	0	0	26	26	0	0	0	13
Hypolimnas bolina	0	0	0	0	0	0	0	13	0	0	0	0
Atrophaneura hector	15	15	45	52	17	19	27	130	41	79	107	78
A. aristolochiae	0	7	0	0	0	0	0	27	0	0	0	0
Graphium agamemnon	42	135	70	0	0	0	0	141	82	0	0	0
Papilio demoleus	0	5	0	0	0	0	0	6	0	0	0	0
P. polymnestor	72	255	121	28	57	25	0	80	0	0	0	0
P. polytes romulus	42	74	39	52	102	35	56	108	73	54	45	46
Anaphaeis aurota	0	0	0	0	0	0	0	7	0	0	0	0
Catopsilia crocale pomona	0	0	0	0	0	0	0	14	0	0	0	0
Valeria valeria anais	39	19	71	152	63	64	54	65	80	87	78	98
Borbo cinnara	31	33	99	127	183	0	54	21	93	71	64	75
Pelopidas mathias	0	0	0	100	272	0	0	0	0	133	113	119
Total visits	986	1,309	1,104	1,305	2,304	1,045	764	1,303	883	1,470	1,522	1,273

number of flowers visited per minute and the length of a visit by the Papilionids set out in Table 5 show that *P. polymnestor* spent less time at a flower and as a result covered more flowers in an unit time. Thus it proved to be more active. As its proboscis length (38 mm) exceeded the corolla tube length (av. 25 mm), it got at the nectar with ease. Species with proboscis shorter than the corolla length had to push their heads into the tube and took more time in foraging (Table 6).

Table 5

NUMBER OF FLOWERS VISITED FOR UNIT TIME AND LENGTH OF A VISIT BY PAPILIONIDS ON *C. infortunatum*

	No. of flowers visited/minute				Length of a visit in seconds			
Papilionid species	n	R	x̄	S.D.	n	R	x̄	S.D.
Atrophaneura hector	10	17-20	18.4	± 1.2	10	3.0-3.5	3.1	± 0.5
Graphium agamemnon	10	30-60	48.2	± 10.8	10	1.0-2.0	1.4	± 0.5
Papilio demoleus	10	30-60	46.0	± 9.8	10	1.0-2.0	1.7	± 0.3
P. polymnestor	10	45-60	50.0	± 12.5	10	1.0-1.5	1.1	± 0.3
P. polytes romulus	10	18-25	20.0	± 3.2	10	2.5-4.0	3.8	± 1.1

Butterflies other than Papilionids used to land on the corolla lobes, insert their proboscids either from above or below the essential floral parts and take nectar pushing their heads into the corolla tube. They always kept their wings folded and static while sucking the nectar and seldom contacted the anthers/stigma. The hawkmoth characteristically hovered a little above the essential flower parts in front of the flower, and thus made no contact with the anthers/stigma.

Table 6

PROBOSCIS LENGTH OF BUTTERFLIES FORAGING ON *C. infortunatum*

Butterfly species	N	Mean Proboscis length (mm)
Barbo cinnara	5	08
Anaphaeis aurota	5	10
Catopsilia pyranthe	5	14
Hypolimnas bolina	4	14
Euploea core	5	15
Graphium agamemnon	5	15
Papilio demoleus	5	16
Valeria valeria anais	5	17
Atrophaneura hector	5	18
Papilio polymnestor	3	38
P. aristolochiae	4	17
P. polytes romulus	5	18

All the flower-visitors recorded are diurnal. *Amegilla* appeared between 0730-1800 hr, but was more frequent between 0800 and 1200 hr. Hawkmoth foraged at around dawn and dusk. The butterflies displayed no regularity in the time of their visits, but were relatively more common in the forenoon.

Although flowers secreted nectar throughout the day and night, no noctuid was observed at the flowers at the biotope studied.

7. **Stigmatic pollen loads:** On the day of the female phase, stigmas were collected at the Botany Garden and the pollen grains on them were counted. The mean pollen load for 60 stigma was 6. Most stigma with pollen also contained butterfly scales.

8. **S/P Ratio:** The area of stigma relative to the area of wing over which the pollen of *C. infortunatum* got smeared, was calculated for five of the Papilionids. The ratio for *P. demoleus* and *G. agamemnon* was 0.089, that for *P. Polytes* 0.084, for *A. hector* 0.076 and for *P. polymnestor* 0.062 (Table 7).

9. **Breeding systems:** The flowers are compatible only to geitono- and xeno-pollen. Fruit set, seed set and fecundity realised on hand-

TABLE 7

S/P RATIO OF THE PAPILIONIDS ON *C. infortunatum*

Papilionid species	N	S/P ratio
Papilio demoleus	5	0.0889
Graphium agamemnon	5	0.0882
Papilio polytes romulus	5	0.0842
Atrophaneura hector	5	0.0762
Papilio polymnestor	5	0.0615

pollinaion with the former pollen type was 73%, 66% and 46% respectively; those with the latter type was 52%, 53% and 28% respectively.

10. **Natural fruit set:** Fruit set, seed set and fecundity observed on natural pollination was 21%, 55% and 26% respectively.

DISCUSSION

Floral morphology and behaviour, and the flower-visitors guild composition and their behaviour undoubtedly showed that the flowers of *C. infortunatum* are tailored for manipulation and pollination exclusively by butterflies. Further, such characteristics of nectar as small quantities in the forenoon hours when the butterflies were active, low sugar concentration, sucrose dominance and richness in amino acids conform to the characters of typical butterfly flowers (Baker 1973, 1975, 1978).

Of the different butterfly visits recorded on *C. infortunatum,* those of *Papilio polytes, Atrophaneura hector* and *Papilio polymnestor* were consistent and substantial. The presence of butterfly scales and the presence of pollen of *C. infortunatum* on the underside of butterfly wing was also demonstrated, and this substantiated the role of butterflies in the pterigotribic pollination of *C. infortunatum.* The manner in which pollination efficiency is achieved is similar to that described for *Caesalpinia pulcherrima* by Cruden and Hermann-Parker (1979).

Both selfing through geitonogamy and out-crossing appear to play a role in the reproduction of *C. infortunatum* as revealed by hand-pollination experiments, but to a varying degree. The flowers are strongly protandrous, male and female phases of the flowers are separated in time and space, probably to avoid deposition of auto-pollen on the stigma, or to avoid damage to the immature stigma by the visitor's wing in the male phase.

The pollinators were seen repeatedly visiting all the opened flowers in an inflorescence, and also making inter-inflorescence and inter-plant movements. It is thus likely that pollinator foraging may result in both geitonogamy and xenogamy. But the small number of flowers opening each day should help to maximise xenogamy (see Cruden 1976). However, controlled experiments revealed that in terms of fruit set, seed set and fecundity the success of geitonogamous mode of reproduction is significantly better than that of xenogamous mode. Apparently this taxon has primarily adapted for selfing through geitonogamy, but with a greater provision for xenogamy, and the attendant genetic variability.

Observations of daily foraging revealed that the pollinator species did not forage continuously. In a single bout they visited several flowers in a population of *C. infortunatum* and flew away, sometimes to nearby *Anacardium occidentale, Antigonon leptopus* to forage on their flowers. Such behaviour is expected on the basis of energy considerations of butterflies (Heinrich and Raven 1972, Heinrich 1975), and has been reported by Cruden and Hermann-Parker (1979), Schmitt (1980), Subba Reddi *et al.* (1981, 1983), Reddi & Subba Reddi (1983) and Meera Bai (1987). The behaviour of pollinators greatly influences the breeding structure of populations and population structure, and thus influences the amount and organisation of genetic variability within the plants (Levin 1978). The drifting behaviour of butterflies then assumes much significance and contributes to inter-population movement of pollen. Such pollen transfers are necessary to have genetic variability because *C. infortunatum* has clonal populations.

Based on their work with wood-white butterfly *Leptidea sinapis* and its nectar plants, Wiklund *et al.* (1979) hypothetically stated that butterfly feeding on nectar plants is only a parasitic relationship. Here is an instance of mutualism where *C. infortunatum* may be considered to have co-evolved with butterflies and whose sexual reproduction is totally dependent on the activity of Papilionids. The study suggested that the relationship, whether parasitic or mutualistic, depends on the flower size and architecture, and on the butterfly size and its behaviour. Thus all the butterfly visitors to *C. infortunatum* have not proved to be pollinators. *Valeria valeria anais* and *Barbo cinnara* failed to contact the essential flower parts because of their small size and behaviour.

Pollen-collecting by the bee component of the flower-visitor guild, particularly by the voracious *Amegilla* sp. is highly detrimental to the reproduction of *C. infortunatum* as it causes a shortage in the availability of pollen for the pterigotribic pollination by the Papilionid butterflies.

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MALE REPRODUCTIVE CYCLE IN SOME INDIAN BATS[1]

A. Gopalakrishna and N. Badwaik[2]

(*With a text-figure*)

Key words: bats, male reproductive cycle

This report embodies observations on the male sex-cycle in twelve species of Indian bats included in eight families. Except *Taphozous longimanus, Pipistrellus dormeri* and *P. mimus*, all the species breed in a sharply defined season. Most of them have a boreal type of sexual rhythm. *Pipistrellus ceylonicus chrysothrix* breeds in the rainy season. The exceptional three species mentioned above breed throughout the year. In all species the male reproductive cycle is either synchronised or adapted to the female sexual cycle.

Introduction

Although India has a rich chiropteran fauna with nearly a hundred species incorporated in nine families, our knowledge about Indian bats is restricted to the study of the general nature of the breeding habits of only the females of a few species. Even from these few studies it is evident that these animals exhibit interesting reproductive strategies. Some information concerning the reproduction in males is available with respect to two megachiropteran species, namely *Cynopterus sphinx* (Sandhu and Gopalakrishna 1984) and *Rousettus leschenaulti* (Gopalakrishna *et al.* 1993) and four microchiropteran species, namely *Scotophilus temmincki* (Gopalakrishna 1948), *Rhinopoma kinneari* (Kumar 1965), *Hipposideros fulvus* and *Pipistrellus ceylonicus chrysothrix* (Gopalakrishna *et al.* 1992, Gopalakrishna and Badwaik 1993). The present study on the male reproductive behaviour of some Indian bats was undertaken not only because there is no information on the male sexual cycle of these species but to find out how the males have adapted to different patterns of reproduction in the females of these species.

Materials and Methods

The reproductive cycle in males of the following species is reported: *Taphozous longimanus* (Emballonuridae), *Megaderma lyra lyra* (Megadermatidae), *Rhinolophus rouxi* (Rhinolophidae), *Hipposideros speoris* (Hipposideridae), *Pipistrellus dormeri, P. mimus mimus, Scotophilus heathi* (all Vespertilionidae) and *Miniopterus schreibersii fuliginosus* (Miniopteridae — Gopalakrishna and Karim 1980) are studied for the first time. Additional information on the male reproductive cycle of *Rousettus leschenaulti* (Pteropodidae), *Rhinopoma microphyllum* (Rhinopomatidae), *Hipposideros fulvus fulvus* (Hipposideridae) and *Pipistrellus ceylonicus chrysothrix* (Vespertilionidae) is also included here. Thus, representatives of all the families available in India except Molossidae are included in the present study. Male specimens of all these species were collected periodically from 5th April, 1981 to 4th March 1987 such that every calendar month is represented by one collection or more. Most of the specimens were collected from Vidarbha, Marathwada and South-Western Madhya Pradesh. All specimens of *Miniopterus schreibersii fuliginosus* were collected at Mahabaleshwar in Western Ghats. A few specimens of *Megaderma lyra lyra* were also collected at and around Bangalore and Mysore in South India and at and around Agra in North India. Table 1 indicates the number of adult male specimens examined for this report during each calendar month. Although specimens of *Hipposideros speoris* were collected from several

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[1] Accepted September 1993.

[2] Department of Zoology, Institute of Science, Nagpur-440 001.

TABLE 1

THE NUMBER OF ADULT MALE SPECIMENS EXAMINED DURING DIFFERENT MONTHS OF THE YEAR (1981-1987)

No.	Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1.	*Rousettus leschenaulti*	8	3	4	5	3	2	2	4	4	2	4	4	45
2.	*Taphozous longimanus*	2	2	4	2	1	3	2	3	2	2	1	2	26
3.	*Rhinopoma m. kinneari*	—	—	4	7	1	1	4	—	4	—	—	—	21
4.	*Megaderma lyra lyra*	5	6	14	4	3	4	9	7	4	4	8	3	71
5.	*Rhinolophus rouxi*	2	2	3	4	2	1	1	4	3	4	4	5	35
6.	*Hipposideros f. fulvus*	7	7	2	8	5	5	7	4	3	6	5	6	65
7.	*Hipposideros speoris*	13	8	5	6	8	5	8	8	5	6	6	8	86
8.	*Pipistrellus c. chrysothrix*	6	5	3	7	9	12	10	7	6	4	5	5	79
9.	*Pipistrellus dormeri*	3	4	4	5	7	6	3	4	3	4	3	4	50
10.	*Pipistrellus m. mimus*	11	6	7	13	3	2	1	4	4	3	2	5	61
11.	*Scotophilus heathi*	3	10	9	3	4	3	3	6	4	2	8	12	67
12.	*Miniopterus s. fuliginosus*	2	7	10	16	12	10	3	2	5	14	11	4	96

localities, the present report embodies descriptions of specimens collected only at Chandrapur (19° 57' N, 79° 21' E) in Eastern Vidarbha. The male cycle of this species in other parts of peninsular India has already been reported (Brosset 1962, Gopalakrishna *et al.* 1991). The specimens were killed by chloroform, their genitalia dissected out and fixed in alcoholic Bouin's fluid. Microscopic examination of the testis and the accessory glands were made on serially sectioned tissues stained with Harris' or Erlich's haematoxylin and counterstained with eosin. A few sections of the accessory glands from each series of sections were also stained by the per-iodic acid-Schiff procedure (Pearse 1968). The present report is based on the examination of the testes and accessory glands of only adult specimens.

OBSERVATIONS AND DISCUSSION

Figure 1 is a schematic representation to indicate the periods of the year when the testis exhibits spermatogenesis and the male accessory glands are active in the species studied here. The figure has been drawn after determining sexual maturity of the specimens by microscopic examination of the structure of the testis and accessory glands of the specimens. The data concerning the season of pregnancy of the various species are taken from earlier reports and are also included in the figure for easy comparison of the reproductive rhythm in both sexes. The following conclusions can be drawn from the figure:

1. In all the species studied here the onset of spermatogenesis and secretory activity in the accessory glands occur nearly synchronously, and, in all but *Hipposideros speoris,* the activity of the two components of the male reproductive system also come to cessation nearly synchronously. In *Hipposideros speoris,* however, the secretory activity in the accessory glands continue to remain at peak level for nearly 14 weeks after the cessation of spermatogenesis in the testis.

2. Sexually active males and pregnant females occur throughout the year in *Taphozous longimanus, Pipistrellus dormeri* and *P. mimus mimus* (*P. dormeri* has been omitted from the figure since its reproductive behaviour in both sexes is exactly similar to that in the other two species). Evidently, these species breed all the year round. Earlier reports on the breeding behaviour of the females of these species (Gopalakrishna 1954, 1955; Gopalakrishna *et al.* 1975, Madhavan 1979) have shown that each female of these species experiences more than one pregnancy during each year as revealed by the fact that females in lactation, and which were also carrying early pregnancy, were available during all the months of the year. This is a strong circumstantial evidence to indicate that each female comes to oestrus within a few days after parturition, and, hence, they may experience several pregnancies occurring in quick succession during each year. Vigorous spermatogenetic activity occurs in the testis of adult specimens during all the months of the year. The accessory glands are also in a high state of secretory activity throughout the year. These facts suggest that males of these species are sexually active throughout the year.

3. In *Rousettus leschenaulti* spermatogenesis occurs from the beginning of October to the middle of April with peak activity occurring twice within this period, once during November-December and a second time during March-April. There is a slightly lessened spermatogenetic activity during January and February. The accessory glands exhibit a similar pattern of activity as the testis except that they come to activity in the middle of October — about two weeks later than the testis. The testis and accessory glands are inactive from the middle of April until the following reproductive season. Females of this species experience two pregnancies in quick succession with the lactation period of the first cycle overlapping the early gestation of the second cycle during March and April (Gopalakrishna 1964, Gopalakrishna and Choudhari 1977).

4. In *Megaderma lyra lyra, Rhinolophus rouxi, Hipposideros fulvus* and *Scotophilus heathi* the testes and accessory glands are active during a

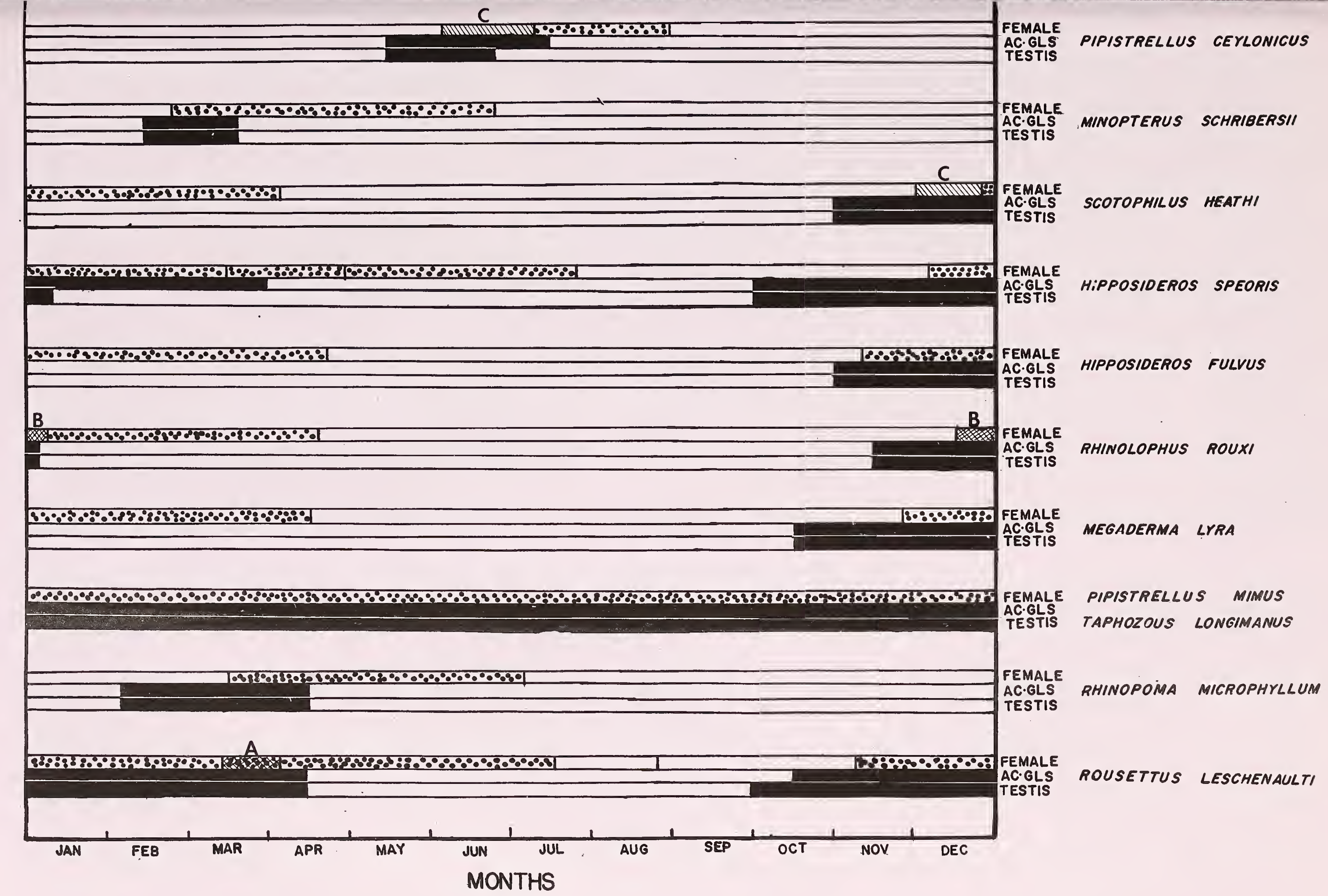

Fig. 1. Schematic representation of the periods of sexual activity in the two sexes in the species studied here. The heavy dark areas indicate the period of sexual activity in the males and the dotted areas indicate the period of sexual activity in the females. A. the period when lactation of the first cycle overlaps the early pregnancy of the second cycle in *Rousettus leschenaulti;* B. Period when there is either delayed implantation or retarded development of the blastocyst in *Rhinolophus rouxi.* C. period when inseminated spermatozoa are stored in the genital tract of the female in *Scotophilus heathi* and *Pipistrellus ceylonicus chrysothrix.*

sharply restricted period, namely from the middle of October to the end of December in *Megaderma*, from the middle of November to about the first week of January in *Rhinolophus*, during November and December in *Hipposideros fulvus fulvus* and *Scotophilus heathi*. In all these species the females come to sexual activity a few weeks later than the males as revealed by the fact that pregnant females were noticed from a date later than the date of onset of activity in the males (Gopalakrishna 1950, Ramakrishna 1951, Ramaswamy 1961, Gopalakrishna and Badwaik 1989, Gopalakrishna and Rao 1977, Madhavan *et al.* 1977, Gopalakrishna and Madhavan 1978, Madhavan 1981). Earlier reports have shown that delayed implantation of the blastocyst (Gopalakrishna and Rao 1977) and retarded early development (Ramakrishna and Rao 1978) occur in *Rhinolophus rouxi* in different parts of India.

In *Scotophilus heathi* (Gopalakrishna and Madhavan 1978, Krishna and Dominic 1978) the inseminated spermatozoa remain viable in the genital tract of the females and fertilise the oocytes released several weeks later. Hence, there is a certain degree of asynchrony between the two sexes in the onset of sexual activity.

5. In *Miniopterus schreibersii fuliginosus* the testes and accessory glands are active for only a short period in the year from the middle of February until the last week of March. Spermatogenetic activity and the secretory activity in the accessory glands occur synchronously. There is a sudden cessation of spermatogenesis and secretory activity in the accessory glands after March. Females are inseminated and conceive in the third week of February and deliver and young ones in the latter half of June (Gopalakrishna *et al.* 1985, personal observations).

6. The testes and accessory glands in *Rhinopoma microphyllum* at Burhanpur (21° 17' N, 76° 16' E) come to activity during the first week of February and remain active until the middle of April, and the males are sexually quiescent during the rest of the year. All adult females in the colony copulate and conceive during the second week of March and deliver the young ones in the first week of July (Badwaik 1991). Kumar (1965), while studying the reproduction in this species at Jodhpur (26° 18' N, 73° 04' E) indicated that fully formed spermatozoa were present within the cauda epididymis and the ampullary glands in varying amounts throughout the year. He further mentioned, "It is not known whether these are functional". The cycle in the female of this species at Jodhpur (Kumar 1965) is nearly similar to that at Burhanpur.

7. In *Pipistrellus ceylonicus chrysothrix* the testes and accessory glands come to activity in the middle of May. While spermatogenesis ceases by the end of the third week of June, the accessory glands continue to be in a state of high secretory activity until the middle of July. Earlier reports on the female reproductive cycle in this species (Madhavan 1971, Gopalakrishna and Madhavan 1977) have shown that copulation occurs during the first two weeks of June and the inseminated spermatozoa remain viable in the female genital tract for several weeks and fertilise the oocytes released in the second week of July.

8. In *Hipposideros speoris* vigorous spermatogenetic activity occurs from October to the first week of January, and the accessory glands come to activity synchronously with spermatogenetis activity. However, the accessory glands continue to maintain a high level of secretory activity until April (Gopalakrishna *et al.* 1992). Further, the cauda epididymis is greatly enlarged and is filled with spermatozoa from November to the end of April even after the cessation of spermatogenesis in the middle of January. Earlier studies on the female sex-cycle of this species at Chandrapur (Gopalakrishna and Bhatia 1983, Gopalakrishna *et al.* 1992) indicated that all parous females conceive in the first week of December, but the first year females conceive as and when they attain sexual maturity any time from January to April. Hence, from January to the last week of July females at different stages of pregnancy were noticed in the colony, and the last delivery occurred on 24th July (the gestation

period being 135 to 140 days). Females in lactation were noticed from May until the last week of September. This species appears to exhibit different types of reproductive patterns at different localities in peninsular India (Brosset 1962, Gopalakrishna *et al.* 1991).

From the foregoing observations it is evident that most species of bats have a highly specific reproductive periodicity, but the precise period of sexual activity varies among different species. Secondly, while most of the species come to sexual activity during November-December (boreal type) a few breed during February-March (austral type). Only *Pipistrellus ceylonicus chrysothrix* is sexually active during May-June. Sexual activity during May-July has been reported in two molossid bats, *Chaerephon plicata* (Gopalakrishna *et al.* 1989) and *Tadarida aegyptiaca* (Gopalakrishna *et al.* 1991) in South Western Madhya Pradesh. The females among the species studied here come to sexual activity a little later in the year than the males. *Rousettus leschenaulti* (Gopalakrishna and Choudhari 1977) appears to incorporate both boreal and austral breeding patterns with the occurrence of two reproductive cycles with a reduced male sexual activity between the two cycles. A similar situation was reported with respect to *Cynopterus sphinx* (Moghe 1956, Sandhu 1984). In *Pipistrellus ceylonicus chrysothrix* (Madhavan 1971, Gopalakrishna and Madhavan 1971) and *Scotophilus heathi* (Gopalakrishna and Madhavan 1978, Madhavan 1981) the inseminated spermatozoa are stored in the genital tract of the female until ovulation takes place.

Hipposideros speoris (at Chandrapur) appears to be unlike all other species because spermatozoa are stored in the cauda epididymis for several days after the cessation of spermatogenesis. From this it is evident that there are at least two separate mechanisms in this species — one which initiates and maintains spermatogenetic activity in the testes and another which triggers and maintains the activity of the accessory glands for a protracted period, and during this period spermatozoa are stored and they remain viable in the cauda epididymis. Evidently, there appears to be a special physiological mechanism by which the chemical medium within the cauda epididymal tubule is maintained in a manner conducive to the long survival of spermatozoa at body temperature.

CONCLUSIONS

The examination of even a few species of Indian bats, among the nearly hundred species inhabiting this country, reveals a variety of breeding patterns and adaptations for successful reproduction. The protracted survival of inseminated spermatozoa, which had been noticed in bats inhabiting cold and temperate countries, has been attributed to the long winter hibernation of these bats in the cold countries. But, in a tropical country, where the bats do not hibernate, the survival of inseminated spermatozoa in *Pipistrellus ceylonicus chrysothrix* and *Scotophilus heathi* and stored spermatozoa in the epididymis of *Hipposideros speoris* at body temperate needs explanation. Further, the seasonal climatic changes in the tropical regions are not so pronounced as in the cold and temperate regions. Yet, the facts, that they exhibit a strict reproductive periodicity, and that this varies among different species, demand explanation.

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FOOD OF JUNGLE BABBLER AND COMMON BABBLER: A COMPARATIVE STUDY[1]

Manjit S. Saini, Manjit S. Dhindsa, Harjeet K. Saini and H.S. Toor[2]

(*With four text-fitures*)

Key words: babblers, *Turdoides striatus, T. caudatus,* feeding ecology, dietary overlap, economic status

Food of the Jungle (*Turdoides striatus*) and Common Babblers (*T. caudatus*) was studied gravimetrically in an intensively cultivated habitat at Ludhiana (India). In both the species, plant matter accounted for >50% of the diet. The remaining portion consisted mainly of insects, while snails (Mollusca) and spiders (Arachnida) formed <1% of the diet. Much of the identifiable bulk of plant matter included pulp of fruits, pearl millet, wheat and leafy material. In *T. striatus*, lepidopterans were the most preferred food as they alone accounted for about 18% of the diet. The other insect orders represented were Orthoptera (5.8%), Hymenoptera (5.7%) and Coleoptera (4.3%). In *T. caudatus* also, lepidopterans were predominant in the diet (16%) followed by coleopterans (8.7%), hymenopterans (5.0%), orthopterans (2.6%) and isopterans (2.5%). Many insect species consumed by both babbler species were pests of the common crops or stored grains. Food niche breadth and dietary overlap of the two species were also calculated.

Introduction

Babblers are among the common birds of India. In Punjab, five species of babblers, namely Large Grey Babbler (*Turdoides malcolmi*), Jungle Babbler (*T. striatus*), Common Babbler (*T. caudatus*), Striated Babbler (*T. earlei*) and Yellow-eyed Babbler (*Chrysomma sinense*) are found (Toor *et al.* 1982). Of these, the first three species are quite abundant. Their food has been studied in Rajasthan (Rana 1970a, b) and Uttar Pradesh (Narang 1986, Narang and Lamba 1986). From Punjab, however, information on food is available on only one species, namely the Large Grey Babbler (Toor and Saini 1986).

Studies on feeding ecology of birds inhabiting intensively cultivated areas are of special interest because of the predominance of food grains in such areas may influence food selection and thereby result in dietary shifts in some species. Such type of shift has actually occurred in the European Starling (*Sturnus vulgaris;* Feare 1989). In this paper we describe results of a study on the food of Jungle Babbler and Common Babbler carried out in an intensively cultivated area of Punjab (India). The objectives of this study were: (i) to make a quantitative analysis of the food, (ii) to study seasonal changes in diet diversity, (iii) to evaluate dietary overlap between the two species, and (iv) to compare food of these species with that recorded in Rajasthan and Uttar Pradesh.

Material and Methods

The study was carried out in the field area of Punjab Agricultural University, Ludhiana (30°56' N, 75°52' E, *c.* 247m above the mean sea level). The area is intensively cultivated with two main crop seasons: *rabi* (October-November to April-May) and *kharif* (June-August to September-December). Predominant crops of *rabi* season are wheat (*Triticum aestivum),* toria (*Brassica campestris*), raya (*B. juncea*), sugarcane (*Sachharum officinarum*), lentil (*Lens esculenta*) and gram (*Cicer arietinum*). Those of *kharif* season include rice (*Oryza sativa*), cotton (*Gossypium* spp.), maize (*Zea mays*), pearl millet (*Pennisetum typhoides*) and groundnut (*Arachis hypogaea*). The climate of the study area is semi-arid monsoon type. Generally,

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[1] Accepted October 1992.

[2] Department of Zoology, Punjab Agricultural University, Ludhiana-141 004, India.

four seasons are experienced in a year: summer (April-June), monsoon (July-September), post-monsoon (October-November) and winter (December-March).

Babblers were shot with an air gun. In total 71 Jungle Babblers and 39 Common Babblers were collected. The guts (oesophagus and stomach) were taken out immediately after shooting and the contents washed through a fine sieve. Washed gut contents were dried on blotting papers for 15-20 min. at room temperature. Animal and plant matter was sorted and weighed on an electric balance true to 0.001 g. After weighing, the plant matter was preserved dry while animal matter was preserved in 70% alcohol for further identification. Two indices of food-niche breadth (Krebs 1989), namely Shannon-Wiener index (H') and Levins' index (B) were calculated as follows:

$$H' = -\sum P_i \log P_i,$$

and

$$B = 1 / \sum p_i^2$$

where, p_i is the proportion of the ith food type in the diet. Levins' index was standardized to express it on a scale of 0 to 1.0 following Hurlbert (1978) as:

$$B_A = (B-1)/(n-1)$$

where, B_A is Levins' standardized niche breadth, and n is the number of food types recorded.

In addition to the gut content analysis, babblers were observed in the field through 7 x 50 field binoculars periodically at different times of the day to record observations on their feeding behaviour, feeding sessions and feeding associations with other birds.

RESULTS

Feeding behaviour: Both species of babblers were resident in the study area. Jungle Babblers preferred thick woody vegetation and fed efficiently on trees. They clung to and hung from the branches to capture insects and to take pecks at leaves. However, Common Babblers preferred low vegetation and remained restricted to bushes in dry areas. They fed mainly under or near bushes but occasionally also out in the open.

Jungle Babblers were observed to feed on pear (*Prunus persica*) fruits in orchards during June and July. However, they ate only those fruits which had already been damaged by Rose-ringed Parakeets (*Psittacula krameri*). Common Babblers fed on pearl millet from July to September. In winter months, they consumed wheat and rice grains shed on the ground but rarely attacked standing crops. Probably because of their apparent shy nature, Common Babblers did not mix with other bird species. However, they sometimes fed in association with House Sparrow (*Passer domesticus*), Weaverbirds (*Ploceus* spp.), Whitethroated Munia (*Lonchura malabarica*), Spotted Munia (*L. punctulata*) and Common Myna (*Acridotheres tristis*).

Food of adults: In both species, plant matter accounted for more than 50% and animal matter about 44% of the diet (Table 1). Grit comprised about 2% of total contents in Common Babbler but only 0.1% in Jungle Babbler.

A major portion of plant matter (22-33%) could not be identified. Of the identified bulk, pearl millet represented about 5% of the diet in Jungle Babbler and 13% in Common Babbler. Wheat constituted 3-4% of the diet in both the species, whereas, rice was eaten only by the Common Babblers, making about 3% of total intake of this species. Common Babblers consumed more leafy material (9%) than Jungle Babbler (3%). Crushed seeds and pulp of fruits formed a considerable portion of the diet of Jungle Babblers but were not recorded in Common Babblers. Weed seeds were consumed in meagre proportions by both species.

Among animal matter, insects represented 34-35% of the diet in the two species. Lepidopterans were predominant insects as they alone constituted 16-18% of the diet. In Jungle Babblers these were followed by orthopterans (5.8%), hymenopterans (5.7%) and coleopterans (4.3%). However, in Common Babblers, coleopterans (8.7%) and hymenopterans (5.0%) ranked second and third respectively in order of relative abundance in diet, while orthopterans formed only 2.6% of the diet.

TABLE 1
FOOD OF JUNGLE BABBLER AND COMMON BABBLER

Food Items	Jungle Babbler (n = 71)	Common Babbler (n = 39)
ANIMAL MATTER		
Phylum Mollusca	0.23	0.32
Phylum Arthropoda		
Class Insecta		
Hymenoptera	5.70	4.99
Coleoptera	4.26	8.66
Lepidoptera	18.18	16.03
Orthoptera	5.80	2.59
Isoptera	0.48	2.49
Diptera	0.28	—
Total insects	35.40	34.26
Class Arachnida	0.61	T
Unidentified animal matter	7.78	9.24
Total animal matter	44.02	44.32
PLANT MATTER		
Pearl millet	5.29	13.22
Wheat	4.25	3.21
Rice	—	2.92
Weed seeds	0.30	1.26
Crushed seeds	4.19	—
Leafy material	3.44	9.37
Unidentified plant matter	32.92	22.34
Pith	5.40	—
Total plant matter	55.81	53.22
GRIT	0.13	2.34
Food Diversity (H')	0.93	0.98
Levins' Index (B_A)	0.31	0.54

T = trace.

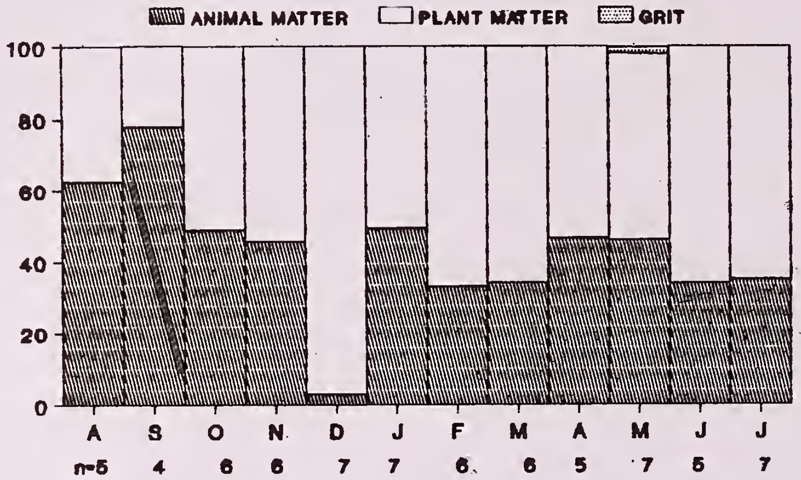
Isopterans and dipterans were consumed in very small quantities by Jungle Babblers (<1% of food). However, in Common Babblers isopterans formed 2.5% of the diet, and dipterans were not consumed at all. Snails (Mollusca) and spiders (Arachnida) formed less than 1% of the diet in both species.

The values of the indices of food niche breadth were more in Common Babbler than in Jungle Babbler (Table 1). Dietary overlap between the two species was 53%.

Seasonal changes in food:

JUNGLE BABBLER: In Jungle Babbler, the relative consumption of animal matter was more than that of plant matter during August and September and almost equal in October (Fig. 1A). During this period, grasshoppers (Orthoptera) were taken most frequently and constituted the major portion (15-22%) of the diet (Fig. 2) Lepidopterans (13%) were the second abundant food type followed by Hymenopterans (5-9%) and Coleopterans (5-14%). Isopterans (5%) and Dipterans (1%) were also consumed in small amounts during this period. Jungle Babblers also consumed spiders during this period but in small quantities (1-2%). Pearl millet (3-33%) was the main food type in the identified bulk of plant matter. In winter (November — February), the quantity of plant matter consumed by Jungle Babblers was more than that of animal matter. A large proportion of plant matter could not

(A) Jungle Babbler, n=71



(B) Common Babbler, n=39

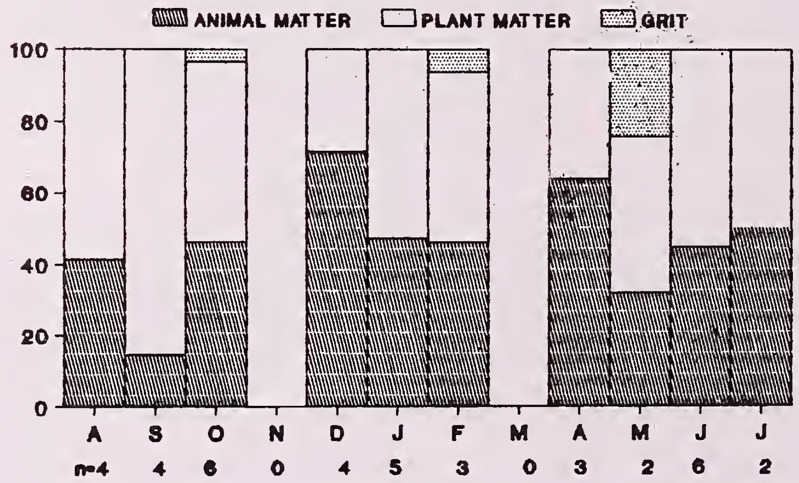


Fig. 1. Seasonal variations in the relative proportion of animal and plant matter in the diet of (A) Jungle Babbler and (B) Common Babbler (n = sample size.)

be identified, but the identified bulk mainly comprised crushed seeds (13-30%) and wheat (3-6%). Leafy material formed less than 5% of the diet in January. Among the animal matter, lepidopterous larvae (16-39%) and ants (3-10%) were the two main food types. From March to July the plant matter remained dominant in the diet of Jungle Babblers. Wheat (4-21%) constituted the major part and was also the most frequently taken food type. Leafy material formed 38% and crushed seeds 6% of the diet in March. In June (33%) and July (43%), large amounts of pulp of pear fruit was eaten. Grit was also recorded in the gut contents of Jungle Babbler in May.

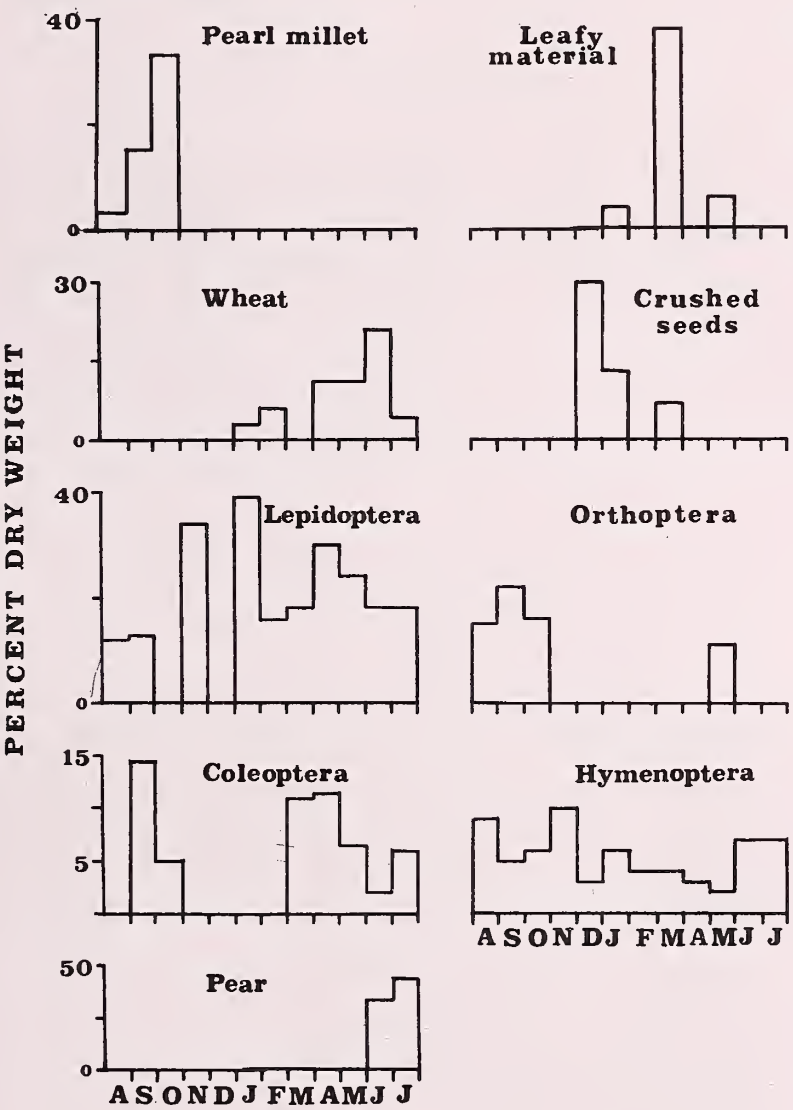


Fig. 2. Seasonal variations in the relative proportion of some important food types in the diet of Jungle Babbler.

Common Babbler: Common Babbler also consumed greater quantities of plant matter than animal matter from August to October (Fig. 1B). The major portion of plant matter eaten was pearl millet (6-66%, Fig. 3). Leafy material (3-15%) was also taken in large amounts. Weed seeds (<2%) and wheat (about 1%) were consumed only in small quantities. Among animal matter various insect orders recorded in the diet in decreasing order were: Lepidoptera (12-14%), Coleoptera (7-10%), Orthoptera (7-9%) and Hymenoptera (1-2%). Snail shell pieces were recorded only in August and constituted less than 1% of the diet. From December to February the relative proportion of animal matter in the diet of Common Babblers increased compared with plant matter (Fig. 1B). Consumption of beetles (Coleoptera) decreased during these months, that of ants (Hymenoptera) remained constant, while an increase in Lepidoptera was observed. In the identified portion of plant matter, significant amounts of leafy material (7-19%) were consumed during these months. Other food types in plant matter were: weed seeds (3-5%), pearl millet (2-13%) and rice (16%, recorded only in February).

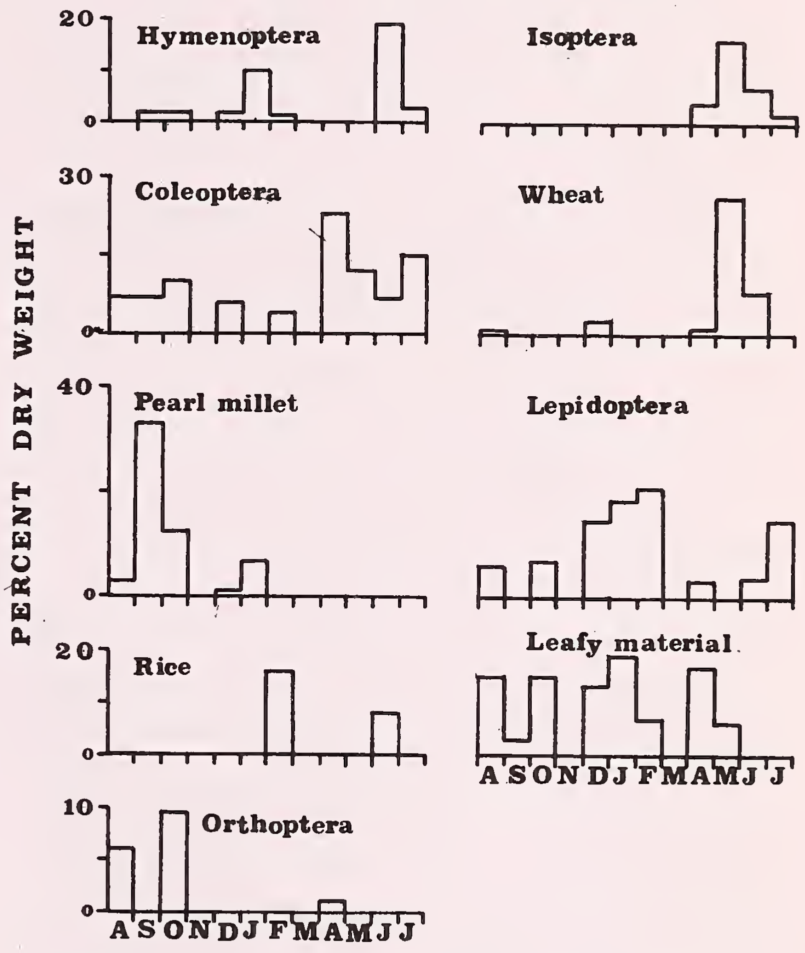


Fig. 3. Seasonal variations in the relative proportion of some important food types in the diet of common Babbler.

In April, the consumption of animal matter was more (64%) as compared to plant matter (36%, Fig. 1B) whereas, in May and June the trend was opposite. However, in July both animal and plant matter were consumed in equal amounts. From April to July, among plant matter, wheat and leafy material were the two food types taken in large quantities (Fig. 3). Other food types recorded in small amounts were rice and weed seeds. Among animal matter, consumption of coleopterans increased during these months. Lepidopterans were also consumed in small proportions except in July when these made 29.4% of the food.

Seasonal variation in food niche breadth: Seasonal variations in the Shannon-Wiener index of food niche breadth revealed that food of Jungle Babbler was more diverse from August to October and May to June than during the rest of the year (Fig. 4A). The maximum value of Shannon-Wiener index was observed in September (0.8) and lowest in December (0.32), Similarly, the maximum value of Levins' index was found in September (0.8) and lowest was in November (0.27). In other months, Levins' index (0.3-0.6) as well as Shannon-Wiener index (0.5-0.7) fluctuated within a narrow range (Fig. 4A). In the Common Babbler the highest value of Shannon-Wiener index (0.88) was observed in October and lowest value in September (0.51, Fig. 4B). However, the maximum value of Levins' index was recorded in May (0.74) and lowest in September (0.17).

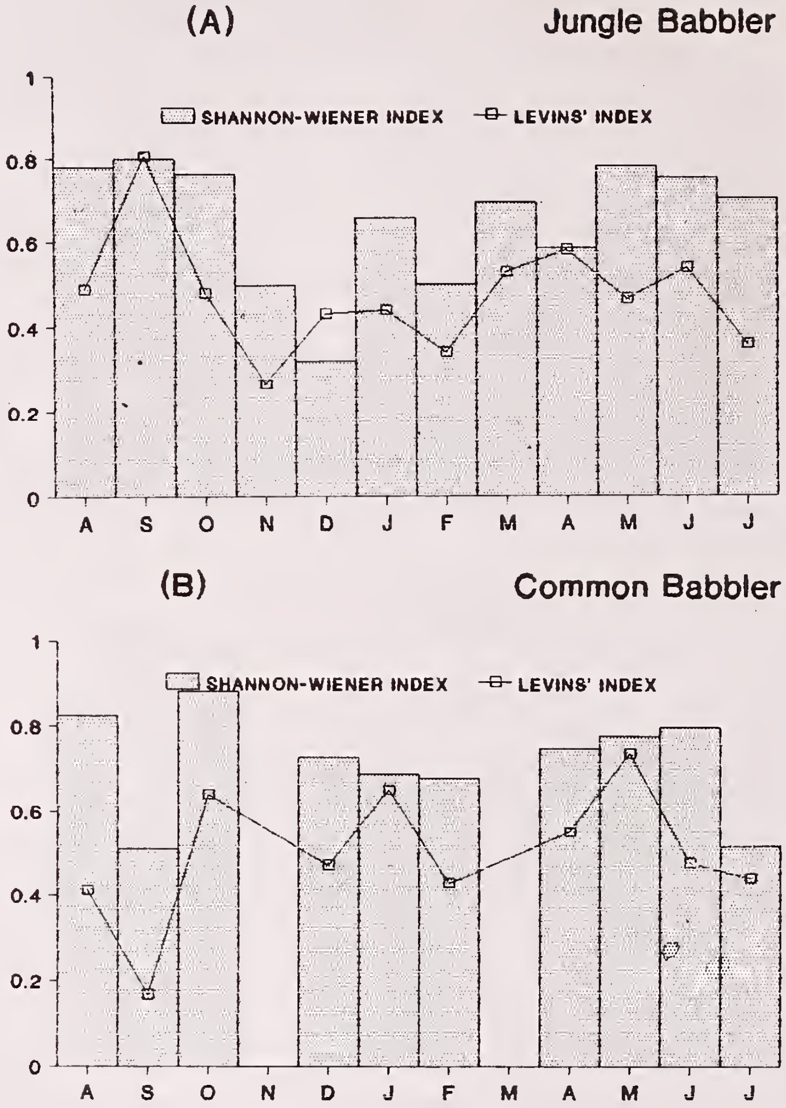


Fig. 4. Seasonal variations in diet diversity of (A) Jungle Babbler and (B) Common Babbler.

Discussion

Both species of babblers were omnivorous consuming almost equal proportions of animal and plant matter. However, interspecific differences in diet were prevalent. For example, the amount of coleopterans consumed by Jungle Babbler was about half the amount eaten by Common Babblers. An exactly opposite trend was observed in the consumption of orthopterans; the consumption of these insects by Jungle Babbler was double the consumption by Common Babbler. Among plant food types, Common Babblers consumed large amounts of pearl millet and leafy material, whereas, the diet of Jungle Babbler was mainly composed of seeds and fruit pulp. These differences must be useful in reducing competition for food between these species should the food become limiting. Different food preferences of sympatric species to reduce interspecific competition for food is, in fact, necessary for their survival (Kear 1962, Schoener 1965, Lack 1966). Differences in the diet may also be related to the spatial distribution and the differences in bill size of the species (Newton 1967, Willson 1972, Gaston 1978, Crase and DeHaven 1978). Most probably, the larger bill of Jungle Babblers (25.10 ± 0.84 mm) enables them to capture the grasshoppers and to feed on fruits more efficiently, whereas, with smaller bills (21.86 ± 1.52 mm). Common Babblers can more easily and efficiently handle beetles and grains of pearl millet

(Saini 1982). Contrary to our results, Rana (1970a) reported that in Rajasthan both Jungle Babblers and Common Babblers fed predominantly on plant matter which represented more than 70% of the diet. Insects formed only about 25% of the diet in his study. These differences may be due to the differences in relative availability of different food types in Punjab and Rajasthan because of different climatic conditions. Narang and Lamba (1986) studied the food of Common Babblers at Dehra Dun and found the species to be omnivorous. In their study, vegetable diet included berries of *Lantana camara* and grains of wheat and paddy, and animal matter consisted of grasshoppers, ants, termites and beetles. However, their results were based on combination of gravimetric and volumetric methods and hence are not comparable to ours.

In both the species of babblers, frequency of occurrence of parts of beetles (Coleoptera) and ants (Hymenoptera) in the gut contents was more than any other insect group. It may not be true to consider that these are the preferred food items because these hard bodied insects may be digested slowly by the birds and thus are usually recovered in more guts. Kalmbach and Gabrielson (1921), while describing the food of starlings, have also stated that coleopteran parts remain for a longer time in the gizzards and their importance gets exaggerated. Moeed (1980) has also supported this view.

Seasonal variation in the food of both the species exhibited a different pattern. During August to October Jungle Babbler fed mainly on animal matter especially, grasshoppers, caterpillars and beetles, whereas, Common Babblers consumed large amounts of plant matter (mainly pearl millet) during this period. Similarly in winter (December to March) Jungle Babbler fed more on plant matter, whereas, Common Babblers consumed animal matter in greater quantities. During winter season per cent increase of lepidopterous larvae in the gut contents suggests that the babblers feed on hibernating larvae. This habit may be contributing towards the reduction in the carry over of the populations of these insects to the next season. It is only during march to July, that plant matter remained dominant in the food of both the species of babblers. Wheat and leafy material were the main food items of the species during the season. In addition to it Jungle Babbler incorporated large amounts of pulp of pear fruits in the diet, whereas, Common Babblers fed on rice grains, taken most probably from the rice nurseries. In Rana's study on babblers, pearl millet was the predominant food of Jungle Babblers throughout the year except during July to September when insects constituted about 54% of the diet. In our study Jungle Babblers consumed pearl millet in significant amounts only in September and October, which is the harvest period of this crop in Punjab. In Rajasthan, Common Babblers consumed large bulk of insects only during March to September (Rana 1970a), whereas, in our study insects formed a significant proportion of the diet throughout the year except in September when pearl millet constituted about 65% of the diet.

In Jungle Babbler the food was more diverse from August to October as they fed on a wide variety of insects and plant matter. In other months, the two indices of food niche breadth fluctuated within a narrow range. However, the lowest diversity recorded in December was due to the intake of large amount of plant matter in the diet. Similarly in Common Babblers the recorded low diversity in September was due to predominance of pearl millet in the diet.

Economic status: Both the species of babblers are omnivorous as they incorporate large amounts of plant matter as well as animal matter in their diet. Among animal matter, insects formed a predominant proportion of the diet. Most of the insects consumed are pests of various crops (Table 2). The identified insects were curculionids (pests of stored grains), chrysomelids (serious pests of cucurbits), coccinelids (pests of vegetables), calliphorids (saprophagous flies), acridids (phytophagous hoppers) and pentatomids (sap sucking insects). The snails consumed by babblers are known to be vectors of infectious diseases of livestock. Jungle Babblers and Common Babblers

TABLE 2

ANIMALS IDENTIFIED FROM GUT CONTENTS OF THE ADULTS OF JUNGLE BABBLER AND COMMON BABBLER

Animal	Jungle Babbler	Common babbler	Remarks
Phylum Mollusca			
Class Gastropoda			
Order Monotocardia			
Family Melaniidae			
Melanoides tuberculatus	+	+	
Phylum Arthropoda			
Class Insecta			
Order Coleoptera			
Family Curculionidae			
Sipalus sp.	+	—	Phytophagous weevils, damage stored grains
Myllocerus sp.	—	+	
Astycus sp.	—	+	Stem borers and leaf feeders
Episomus sp.	—	+	
Family Chrysomelidae			
Neorthea fulva	+	—	Serious pest of cucurbits
Family Coccinellidae			
Scymnus sp.	+	—	Destructive to vegetables
Family Elateridae	—	+	
Order Diptera			
Family Calliphoridae			
Calliphora sp.	+	—	Saprophagous fly
Order Hymenoptera			
Family Formicidae	+	+	
Pheidole sp.	+	—	
Cataglyphus bicolor	+	—	
Order Orthoptera			
Family Acrididae	+	+	
Acrotylus sp.	+	—	
Acrida sp.	+	—	Phytophagous hoppers, feed on leaves of rice, grasses and millets
Colemania sp.	+	—	
Family Tettigonidae	—	+	
Class Arachnida			Spiders in general are predators of insect pests and thus useful animals
Order Aranae			
Family Salticidae	+	—	
Family Clubionidae			
Clubiona sp.	+	—	

feed on pearl millet during the postmonsoon months, but the damage is not of much concern in our area as this crop is cultivated as fodder only. Wheat and rice grains are consumed in small quantities and those too are taken from the ground, where they fall as a result of damage by other birds. Jungle Babblers do some damage to pear fruits during June and July, but this damage is not of primary nature as babblers mainly feed on only those fruits which have already been damaged by Rose-ringed Parakeets. Therefore, the present studies reveal that babblers are useful species in relation to agriculture as they keep an efficient check on various types of insects which are injurious to our crops and stored grains.

Acknowledgements

We wish to thank Dr. J.S. Mann for help in identification of insects. This study was supported by the Indian Council of Agricultural Research, New Delhi.

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TAXONOMIC STUDIES ON THE SPECIES OF *HOLOTHURIA* LINNAEUS, 1767 FROM THE SEAS AROUND INDIA[1]

Part 2

D.B. James[2]

(With a plate and two text-figures)

[*Continued from Vol. 92(1):* 62]

Holothuria (Mertensiothuria) leucospilota (Brandt)

(Pl. 2, A; Fig. 3, A-C)

Stichopus (Gymnochirota) leucospilota Brandt, 1835, p. 51.

Holothuria vagabunda Bell, 1886, p. 28: Mergui Archipelago; Bell, 1887a, p.140: Andaman Island; Bell, 1888, p.389: Tuticorin (Gulf of Mannar); Thurston, 1894, p. 115: Tuticorin (Gulf of Mannar); Pearson, 1903, p. 201: Ceylon (Sri Lanka); Kochler & Vaney, 1908, p. 17: Andaman Island; Laccadives (Lakshadweep).

Holothuria leucospilota A.M. Clark & Davies, 1966, p.603: Maldives; James, 1969, p. 62: Gulf of Mannar, Arabian Sea, Andamans, Laccadives (Lakshadweep); James, 1982, p. 5; Tikader & Das, 1985, p. 99: Andaman & Nicobar Islands; James, 1987, p. 110: Hut Bay (Little Andamans).

Holothuria (Mertensiothuria) leucospilota James, 1982, p. 92: Goa (West coast of India); Soota, Mukhopadhyay & Samanta, 1983, p. 511: Trinket, Nancowry Harbour, Sound Island (Andaman & Nicobar Islands); Mukhopadhyay & Samanta, 1983, p. 305: Lakshadweep; Price & Reid, 1985, p. 4: Galle (Sri Lanka); James, 1986a, p. 585: Lakshadweep-Maldives, Sri Lanka, Gulf of Mannar —Palk Bay, Andaman-Nicobar Islands; James, 1989b, p. 127: Chetlat, Kiltan, Kadmat, Amini, Androth, Kavaratti, Minicoy (Lakshadweep).

Material: Tuticorin (Gulf of Mannar), several specimens; Kilakarai, one specimen; Vizhinjam (Arabian Sea), two specimens; Karwar (West Coast), one specimen; Ratnagiri (Arabian Sea), one specimen; Port Blair (Andamans), several specimens; Hut Bay (Little Andamans), several specimens; Chetlat, several specimens; Kiltan, several specimens; Kadmat, four specimens; Amini, several specimens; Kavaratti, three specimens; Minicoy, five specimens (Lakshadweep), all specimens collected from the intertidal region or from littoral waters, less than a metre in depth.

Description: Large and snake-like forms with leathery skin. The pedicels are large with well developed sucking discs. The tentacles are 20 in number and are ventrally placed. There is a well developed tentacular collar with a fimbriated margin.

In the calcareous ring each radial is large and has a deep groove while the interradial is a short, stump-like projection. There is a single polian vesicle and a single stone canal. The respiratory trees are well developed. Cuvierian tubules are also well developed.

The spicules (Fig. 3, A-C) consist of an external layer of tables with complete or incomplete discs often reduced to four holes, one at the base of each pillar. Spire is low and often partly reduced, but when complete, it ends in a flattened crown of eight or twelve teeth. Inner layer consists of regular six holed buttons. The buttons may sometimes be asymmetrical. Pedicels are with large end plates and a few broad perforated plates with more or less slit-like holes. The buttons (Fig. 3, B) in a specimen collected from Kilakarai (Gulf of Mannar) were mostly incomplete and have a dumb-bell shape with a pair of holes at either end. They were in the process of breakdown. The length of the buttons varies from 0.050 mm to 0.063 mm, and the breadth varies from 0.025 mm to 0.033 mm. The height of the table is *c.* 0.042 mm and the diameter of the disc varied from 0.037 mm to 0.054 mm.

When alive, the colour is reddish-brown but looks black on contraction.

Notes on habits: The species has the peculiar habit of tucking its posterior end under a stone. The

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[1] Accepted October 1992.

[2] Central Marine Fisheries Research Institute, Kochi 682031.
Present Address: Tuticorin Research Centre of CMFRI, 90 North Beach Road, Tuticorin 628 001.

anterior end which projects out from the stone keeps on moving with the ventrally directed tenacles. Specimens were sometimes found under coral stones. On being disturbed the animal throws out the cuvierian tubules which are abundant. At Hut Bay (Little Andamans) during February, 1977 in some places as many as 5 to 6 were distributed per square metre. It was also found to be common on the pearl oyster beds off Tuticorin.

Remarks: Both the species *Holothuria (Halodeima) atra* and *Holothuria (Mertensiothuria) leucospilota* are black and occur together at some places. However, they can be separated in the field by the following differences. *Holothuria (Halodeima) atra* is free from cuvierian tubules whereas the other species has plenty of them. The former, when handled in the field, releases a toxin known as holothurin which is red in colour, whereas in the latter species the red toxin is absent. In some places, *Holothuria (Halodeima) atra* is covered by a coating of fine sand, whereas in *Holothuria (Mertensiothuria) leucospilota* sand never covers the body. Finally the former species lies fully exposed without making any attempt to conceal the body, while the latter species keeps the posterior end of the body tucked under a stone. A similar character is also exhibited by the holothurian *Holothuria (Acanthotrapeza) pyxis.* By the above differences, both the species can be separated in the field without any difficulty.

Distribution: This species is widely distributed and is known from the islands of Western Indian Ocean, Mascarene Islands, East Africa, Red Sea, S.E.Arabia, Persian Gulf, Maldives, Lakshadweep, Sri Lanka, Bay of Bengal, North Australia, Philippines, China, South Pacific islands and Hawaiian Islands. James (1969) reported the species for the first time from the Arabian Sea.

Subgenus *Lessonothuria* Deichmann, 1958

Diagnosis: Tentacles 17-30; pedicels and papillae irregularly arranged ventrally and dorsally respectively, a 'collar' of papillae evident around the base of the tentacles, anal papillae usually apparent; body wall soft, not very thick, usually 1(1-3 mm); body almost cylindrical but with more or less distinct, 'flattened' 'sole'; size small to moderate up to 150 mm long; calcareous ring fairly stout, radial plates about twice as long as the interradial plates; spicules consisting of clumsy tables, the spire low to moderate and usually terminating in a ring or cluster of spines, disc well developed and spinose, rarely some tables with smooth-rimmed disc also present, rim often turned up to give a 'cup and saucer' appearance to the table in lateral view, pseudobuttons abundant, usually smooth, sometimes spinose, usually irregular in outline and often reduced to single row of three or four holes, occasionally quite regular buttons are present, with three pairs of holes.

Type-species: *Holothuria pardalis* Selenka, 1867; designated by Deichmann, 1958:295.

Six species are included under this subgenus. Only one species is known from the Indian seas.

Holothuria (Lessonothuria) pardalis Selenka
(Fig. 3, D & E)

Holothuria pardalis Selenka, 1867, p. 336: Sandwich Island (Hawaiian Island); Ludwig, 1887, p. 1226: Ceylon (Sri Lanka); Theel, 1886, p. 224: Nicobar; Bell, 1888: Gulf of Mannar; Koehler & Vaney, 1908, p. 13: Tavoy, Mergui Archipelago, Cheduba Island, Andaman Island; Gravely, 1927, p. 164: Gulf of Mannar; Gideon *et al.* 1957, p. 704: Gulf of Kutch; Sane & Chhapgar, 1962, p. 673: Bombay; A.M.Clark & Davies, 1966, p. 600: Maldives: Gopalakrishnan, 1969, p. 400: Gulf of Kutch; James, 1969, p. 61: Gulf of Mannar, Andamans, Laccadives (Lakshadweep), Gulf of Kutch; Nagabhushanam & Rao, 1972, p. 291: Minicoy Atoll (Lakshadweep); Satyamurti, 1976, p. 51: Shingle Island (Gulf of Mannar).

Holothuria lineata Bell, 1887a, p. 140: Andaman Island.

Holothuria caesarea Bell, 1887b, p.654: Ceylon (Sri Lanka).

Holothuria (Lessonothuria) pardalis James, 1989b, p.127: Chetlat, Bitra, Kiltan, Minicoy (Lakshadweep).

Material: Pulli Island (Gulf of Mannar), four specimens; Port Blair (South Andamans), several specimens; Rangat Bay (Middle Andamans), two specimens; Mayabunder (North Andamans), one specimen; Port Okha (Gulf of Kutch), two specimens; Ratnagiri (west coast of India), one specimen; Chetlat, three specimens; Kiltan, four specimens; Minicoy, two specimens; (Lakshadweep); Specimens from Pulli Island

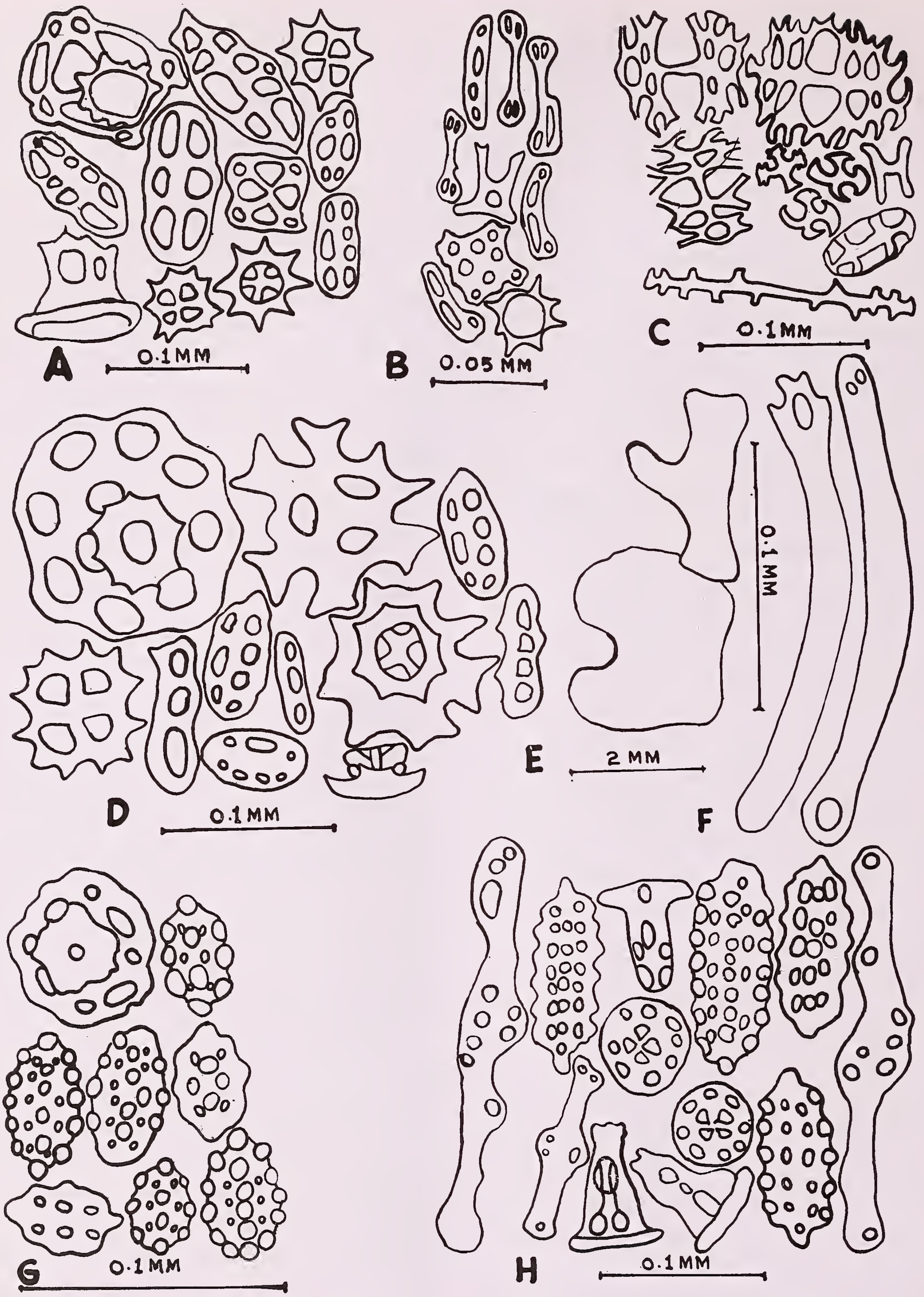


Fig. 3. Spicules of: A-C. *Holothuria (Mertensiothuria) leucospilota* - A. Spicules from the body wall; B. Spicules in the process of breakdown; C. Spicules from tubefeet; D. *Holothuria (Lessonothuria) pardalis*; E. Radial and interradial plates of *Holothuria (L.) pardalis*; F. Spicules from the tubefeet of *Holothuria (L.) pardalis*; G. *Holothuria (Cystipus) rigida* (from adult specimen); H. *Holothuria (Cystipus) rigida)* (from juveniles).

collected from dead coral crevices and other specimens collected under coral stones in the intertidal region.

Description: The length of the specimens examined ranged from 50 mm to 150 mm. The body is spindle-shaped, tapering at both ends. Mouth and anus are terminal. The mouth is surrounded by 20 small tentacles and anus is surrounded by a crown of papillae. The dorsal and ventral sides are not well demarcated. The papillae and pedicels are small and few. They are not arranged in rows or bands. The papillae are 3-4 mm in length and the pedicels are provided with larger discs. The body wall is smooth and thin.

The calcareous ring is comparatively small and delicate, the pieces being rather loosely joined. Interradials are as wide as or wider than the radials (Fig. 3, E). Each radial piece is prolonged slightly further forward than the interradial and has the usual roundish incision. The anterior edge of the interradial has a small tooth. In a specimen dissected, there were two polian vesicles and a single stone canal. The left tree is much longer than the right one.

The spicules (Fig. 3, D) consist of tables, buttons and curved rods. The tables are provided with spinous discs, usually somewhat irregular in shape and have a low spine with generally eight teeth. The top of the table is square-shaped. The diameter of the discs of the table varies from 0.048 mm to 0.066 mm, and the height of the tables varies from 0.045 mm to 0.052 mm. The disc of each table has a central hole and eight small peripheral holes. Four spires arise from the base of the disc and are connected by a cross beam. The edge of the disc is slightly irregular, and in some specimens the edge is smooth and slightly raised. Buttons and pseudobuttons are present. The buttons are arranged in rings or in circles and are smooth with three or four pairs of holes. The pseudo-buttons are usually irregular in outline and often reduced to a single row of three or four holes. The length of the buttons varies from 0.038 mm to 0.91 mm, and the breadth from 0.017 mm to 0.038 mm.

Colour is variable. In the living condition light brown with white and dark patches. In large forms (150 mm in length) there are 8 to 15 pairs of brown spots. Small specimens (50 mm in length) are light brown with very small brown specks scattered over it. Spots characteristic of the adult are absent.

Remarks: Specimens below 50 mm are difficult to separate from *Holothuria (Thymiosycia) arenicola,* since both show the same colour pattern and live together. In small *Holothuria (Thymiosycia) arenicola,* the cloacal opening has a light brown ring round it. The species *Holothuria (Lessonothuria) multipilula* described as new by Liao (1976) is based on a young specimen (48 mm in length) of *Holothuria (Lessonothuria) pardalis.* The differences pointed out by him in the tables are clearly due to the immaturity of the specimen.

Notes on habits: This is one of the commonest holothurians around Port Blair (Andamans) and also at Lakshadweep, usually found buried in sand under coral stones. Though not an active holothurian, the tentacles are well extended during movements. It occurs along with *Holothuria (Thymiosycia) impatiens, H. (Thymiosycia) arenicola* and *H. (Thymiosycia) hilla.* A fossorial form like *H. (Thymiosycia) arenicola,* the surface of the body has very few pedicels and papillae and the body appears to be smooth. Burrowing is effected through the alternate circular and longitudinal contractions of the muscles. At Pullivasal Island in the Gulf of Mannar, this species lives inside the crevices of dead coral colonies. It was impossible to pull out the specimens from the coral crevices as they were too large for the crevices. When the holothurians were small, they must have entered the coral crevices to take shelter, and as they grow larger their body gets constricted at certain places in order to be accommodated in the crevices, as the holothurians themselves cannot bore into the corals. Most of the specimens, when they were removed from the dead coral colony by breaking the colony into small pieces, were found to have deep scars, constrictions and different colour pattern at the places of constriction. The obvious reason for the holothurians to lodge themselves in the coral colony is for shelter. For food, they have to entirely depend on the organisms swept in by the current of water during high tide. At Chetlat Island in Lakshadweep, one specimen was lodged deep in a dead coral colony.

Distribution: It is known from the islands of the Western Indian Ocean, Mascarene Islands, East Africa and Madagascar, Red Sea, S.E. Arabia, West Cost of India, Lakshadweep, Sri Lanka, Bay of Bengal, East Indies, North Australia, Philippines, China, South Pacific Islands and the Hawaiian Islands. James (1969) recorded it for the first time from Lakshadweep. A widely distributed species.

Subgenus *Cystipus* Haacke, 1880

Diagnosis: Tentacles 20; pedicels more or less confined to the ventral ambulacral areas, papillae small and scattered dorsally, a lateral flange of papillae sometimes evident, anal papillae and 'collar' of papillae around the base of the tentacles not apparent; body wall not very thick, usually 2 (1-8) mm, often gritty to the touch; body rather vermiform or dorsoventrally flattened; size small to moderate, up to 200 mm long; calcareous ring fairly stout with radial plates twice as long as interradial plates, spicules consisting of tables with usually knobbed discs and low spire bearing many short spines which are sometimes numerous, buttons usually simple with large regularly or irregularly arranged knobs, generally 3-4 pairs, but up to 7 pairs, of relatively small holes which may become obscured somewhat by the immensity of the knobs, rarely the buttons are modified into fenestrated ellipsoides.

Type-species: *Cystipus pleuripus* Haacke, 1880, by monotypy; a synonym of *Stichopus rigidus* Selenka, 1867, according to Deichmann, 1958.

Rowe (1969) included nine species under this subgenus. He is of the opinion that all of them included under the subgenus *Cystipus* are valid. The nominal genera *Fossothuria* and *Jaegerothuria* of Deichmann (1958) are synonymous with the subgenus *Cystipus*.

Four species are known under this subgenus from the Indo-West Pacific. Only one species is known from Indian seas.

Holothuria (Cystipus) rigida (Selenka)
(Fig. 3, G - H)

Stichopus rigidus Selenka (Partime) 1867, p. 317: Zanzibar, Hawaii.

Holothuria rigida James, 1982, p. 5; Tikader & Das, 1985, p. 99: Andaman & Nicobar Islands;

Holothuria (Cystipus) rigida Soota *et al.* 1983, p. 509: Port Blair, Little Andaman, Sound Island, Nancowry; James, 1986a, p. 585: Lakshadweep-Maldives, Andaman-Nicobar Islands; James, 1989b, p. 127: Kiltan (Lakshadweep).

Material: Port Blair (South Andamans), four specimens, Mayabunder (North Andamans), one specimen; Kiltan (Lakshadweep), two specimens, all found buried in the sand under stones in the intertidal region.

Description: The specimens examined varied in length from 20 mm to 90 mm. The body is dorso-ventrally flattened with the two ends blunt. The body wall is rigid. The dorsal side is convex and the ventral side is flat. The body is clearly demarcated into dorsal and ventral sides by the presence of flange of papillae which are triangular. In small forms (30-50 mm in length), the dorsal side has low warts of different sizes. On the ventral side, there are three bands of pedicels. Each band has two rows of pedicels. They are small and retracted. In large forms (90 mm in length), the dorsal side is smooth and free from warts. On the midventral region there are two rows of pedicels which are closely placed. The other two rows of pedicels are just below the lateral flange of papillae. These rows are distinct with two or three pedicels arranged side by side.

The radial pieces have the anterior end broader with a deep notch and small depression at the narrow posterior end. The interradials have an anterior knob-like projection (Fig. 3, H).

The spicules consist of buttons, tables and supporting plates. In large forms (90 mm in length), the buttons (Fig. 3, G) are short with regular knobs on them. Each button has eight knobs at the centre. The length of the buttons is 0.08 mm, and the breadth is 0.04 mm. In large forms, some of the buttons are without knobs and have three pairs of holes. In smaller forms (35 mm in length) the buttons are long with seven knobs on each side. The tables are simple with 1-3 knobs and end in two or three low projections. The supporting plates in the pedicels are roughly fusiform with one or two holes at either end and a few holes at the centre.

In the living condition, the colour is yellowish-white on the dorsal side and light yellow on the ventral side. Larger forms have ten pairs of light black spots on the dorsal side.

Remarks: *Holothuria jousseaumei,* described by Cherbonnier (1955) from the Red Sea, is a synonym of *Holothuria (Cystipus) rigida,* since the new species is based on a young specimen of 30-40 mm length. A specimen of *H. (Cystipus) rigida* of 35 mm length collected from Port Blair (Andamans) has the same type of spicules described for *H. jousseaumei* by Cherbonnier (1955). After its first report, no specimen has been referred to this species.

The specimens identified as *H. (Cystipus) rigida* by Mukhopadhyaya (1988) appear to have been based on juvenile specimens of *H. (Metriatyla) scabra* which are common in the localities mentioned by him. The spicules of juveniles of *H. (Metriatyla) scabra* (Fig. 4, B) bear a resemblance to those of *H. (Cystipus) rigida.* It was not possible to get the specimens from the Indian Museum to re-examine them.

Notes on habits: It is a secretive species found buried in sand and lives under stones. In small specimens (30-50 mm in length), sand sticks to the body as a coating. It is an inactive holothurian, showing very little movement in the living condition, thus it escapes attention during collection.

Distribution: Known from the Mascarene Islands, East Africa and Madagascar, Red Sea, East Indies, North Australia, Philippines and South Pacific Islands. James (1986a) reported this species for the first time from the Bay of Bengal and from the Lakshadweep (James 1989b).

Subgenus *Theelothuria* Deichmann, 1958

Diagnosis: Tentacles 18-20; pedicels irregularly arranged on the flattened ventral surface, papillae small to large and conical, irregularly arranged dorsally except for the lateral flange of papillae, a 'collar' of papillae usually present around the base of the tentacles, anal papillae usually apparent; body wall usually very thin and parchment-like, rarely more than 1 (1-2) mm thick, gritty to the touch; body with a distinctly flattened ventral 'sole,' arched dorsally; size moderate to large, up to 250 mm long; calcareous ring stout and well developed, radial plates with more or less well developed posterior bifurcations, radial plates up to twice as long as the interradial plates, both radials and interradials may be longer than broad; spicules consisting of well-developed tables with smooth or spinose discs, sometimes the disc multi-armed, spire low, moderate or high, usually terminating in a cluster of small spines, some tables with perfectly smooth spire tapering to a pointed apex giving the whole table a tack-like appearance, buttons either simple with irregular moderate-sized knobs or modified into fenestrated ellipsoids.

Type-species: *Holothuria pinceps* Selenka, 1867; designated by Deichmann, 1958:325.

Ten species are included in this subgenus of which only one is known from the seas around India.

Holothuria (Theelothuria) spinifera Theel, 1886

(Pl. 2, B; Fig. 4, A)

Holothuria spinifera Theel, 1886, p. 175: Philippines; Pearson, 1913, p. 88: Ceylon (Sri Lanka); James, 1969, p. 61: Gulf of Mannar & Palk Bay; James, 1973, p. 710: Gulf of Mannar & Palk Bay; James, 1982, p. 5; James, 1983a, p. 102; Rao *et al.*, 1985, p. 89: Gulf of Mannar.

Holothuria (Theelothuria) spinifera Mary Bai, 1980, p. 15; James, 1986a, p. 585: Sri Lanka, Gulf of Mannar-Palk Bay; James, 1986b, p. 1: Gulf of Mannar & Palk Bay, James, 1989a, p. 6: Gulf of Mannar & Palk Bay.

Material: Mandapam (Gulf of Mannar), two specimens, at 5 metres depth; Devipattinam (Palk Bay), several specimens, 2-10 metres; Tuticorin (Gulf of Mannar), several specimens, 2-5 metres.

Description: The specimens examined were 150-200 mm in length. The body is cylindrical and robust with both ends rounded. Mouth is surrounded by a collar of papillae. There are 20 tentacles. Anus is surrounded by five distinct cylindrical papillae, which gives a stellate appearance. On the dorsal side, there are a number of long papillae which are sparsely distributed. On the ventral side, there are large pedicels which are thinly distributed. There is no regular arrangement either for the pedicels or papillae.

Spicules (Fig. 4, A) consist of buttons, tables and supporting plates. The buttons are either knobbed or smooth. Very small buttons are smooth. Generally there are three pairs of holes for each button. Sometimes the middle hole is larger than the other two. Very rarely, some buttons are smooth. The length of the buttons varies from 0.035 mm to 0.066 mm, and the breadth from 0.024 mm to 0.038 mm. The tables have short spires and broad discs. Generally there are 8 to 10 peripheral holes which are oval in shape. At the centre of the spire, there is a single hole. The top of the spire ends in an expanded rectangle which has spinous margins. There is a single cross-bar for each table. The height of each table is 0.07 mm. The diameter of the discs varies from 0.071 mm to 0.085 mm. The papillae have long tables which have irregular discs with numerous holes. The spire has two to four holes and two to three cross beams. The tip of the spire of these tables is blunt. The height of the tables varies from 0.21 mm to 0.026 mm, and width varies from 0.12 mm to 0.28 mm. The supporting plates are numerous and common among the calcareous deposits of this species.

The supporting plates are large and most of them are elongated, while a few are short and broad. Each of them has a number of holes. Generally, the tables at the centre are larger than those at either end. The length of the supporting plates varies from 0.10 mm to 0.28 mm, and breadth from 0.047 mm to 0.141 mm.

In the living condition, light brown with white markings. The ventral side is paler in colour.

Distribution: The distribution of this species is restricted. It is known from the Red Sea, Persian Gulf, Gulf of Mannar and Palk Bay, Sri Lanka, North Australia, Philippines and China.

Remarks: Earlier, this was one of the two species commercially processed from the Gulf of Mannar and Palk Bay. Hornell (1917) wrote that this species has a very high value for *Bêche-de-mer,* but in recent years this is not preferred by buyers.

Subgenus *Metriatyla* Rowe, 1969

Diagnosis: Tentacles 20; pedicels irregularly arranged on the flattened ventral 'sole', papillae usually quite large and conical and irregularly arranged dorsally, a lateral flange of papillae sometimes evident, a 'collar' of papillae around the base of the tentacles often present, anal papillae variously developed; body wall usually quite thin, about 2 (1-5) mm thick, and gritty to the touch; body is usually flattened ventrally, arched dorsally; size small to moderate, up to 200 mm long; calcareous ring quite well developed with radial plates up to three times as long as the interradials; spicules consisting of well-developed tables with smooth disc and spire either of moderate height or high, terminating in a few to many small spines, tables rarely absent, buttons simple, with moderate-sized irregularly arranged knobs and three to ten pairs of relatively large holes.

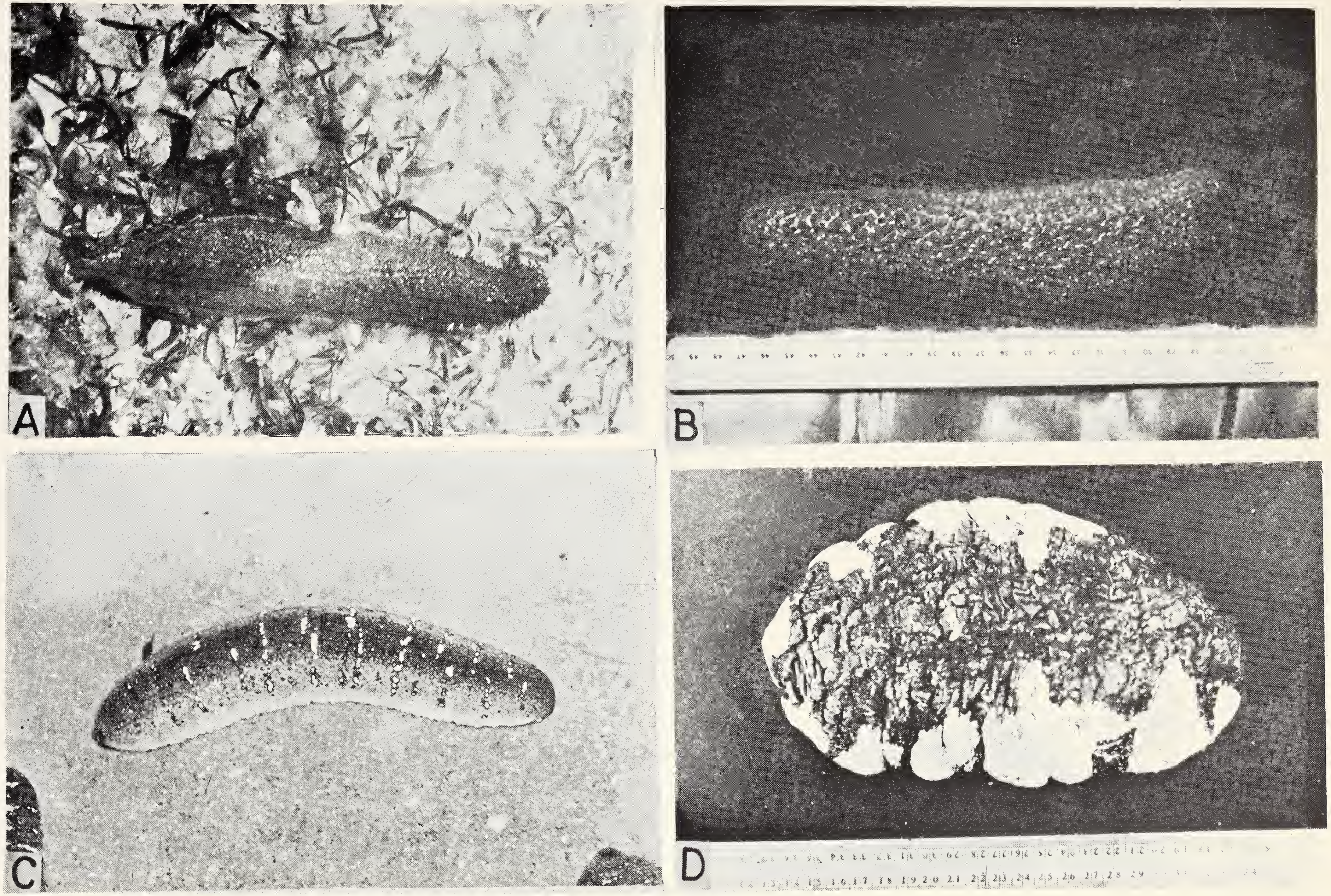
Type-species*:* *Holothuria scabra* Jaeger, 1833:23; designated by Rowe, 1969:160. Nine species are included under this subgenus. Four species are known from the seas around India. One species has been collected and presented in this work.

KEY TO THE INDIAN SPECIES OF THE SUBGENUS

1. Tables high, with up to seven cross pieces .... *H. (Metriatyla) martensi* Semper, 1868
1'. Tables of moderate height.. 2
2. Tables terminate in a large mass of spines .... *H. (Metriatyla) albiventer* Semper, 1868
2'. Tables terminate in a few small spines 3
3. Dorsal side of the body usually with light yellow cross bands .... *H. (Metriatyla) scabra* Jaeger, 1833
3'. Dorsal side of the body with round markings .... *H. (Metriatyla) ocellata* Jaeger, 1833

Holothuria (Metriatyla) scabra Jaeger
(Pl. 2, C; Fig. 4, B & C)

Holothuria scabra Jaeger, 1833, p. 23: East Indies; Ludwig, 1887, p. 1224: Ceylon (Sri Lanka); Koehler & Vaney, 1908, p. 16: Andaman Islands, Mergui Archipelago; Pearson, 1910, p. 193: Mergui Archipelago; Gravely, 1927, p. 165: Gulf of Mannar. James, 1969, p. 61: Gulf of Mannar, Gulf of Kutch; James, 1973, p. 710: Gulf of Mannar & Palk Bay; Satyamurti, 1976, p.53: Krusadai



A. *Holothuria* (*Mertensiothuria*) *leucospilota* (*in situ*); B. *Holothuria* (*Theelothuria*) *spinifera*; C. *Holothuria* (*Metriatyla*) *scabra*; D. *Holothuria* (*Microthele*) *nobilis*.

Island (Gulf of Mannar); James, 1978, p. 60: Palk Bay; Parulekar, 1981, p. 33: Malvan; James, 1982, p. 5: James, 1983a, p. 94: James, 1983b, p. 85: Mayabunder, Diglipur (Andamans); Tikader & Das, 1985, p. 99: Andaman & Nicobar Islands; Rao *et al.*, 1985, p. 89: Gulf of Mannar & Palk Bay; James, 1987, p. 112: Diglipur & Mayabunder (Andamans).

Holothuria cadelli Bell, 1887a, p. 144: Andaman Island; Daniel & Halder, 1974, p. 419: Andamans.

Holothuria gallensis Pearson, 1903, p. 203: Ceylon (Sri Lanka).

Holothuria (Metriatyla) scabra Mary Bai, 1980, p. 15; Soota, *et al.* 1983, p. 512: Andamans; James, 1986a, p. 585: Lakshadweep-Maldives, Sri Lanka, Gulf of Mannar & Palk Bay; James, 1986b, p. 2: Gulf of Mannar & Palk Bay, Andamans, Gulf of Kutch; James, 1989b, p. 6: Andamans, Gulf of Mannar & Palk Bay; James, 1991, p. 651.

Holothuria (Metriatyla) ocellata Mukhopadhyay, 1988, p. 6: Gulf of Mannar (Non Jaeger, 1833, p. 19).

Holothuria (Cystipus) rigida Mukhopadhyay, 1988, p. 7: Krusadai, Pamban, Mandapam Camp, Vedalai, (Gulf of of Mannar) (Non *H. scarba* Jaeger, 1833, p. 19.

Material: Diglipur (North Andamans), several specimens; Rangat (Middle Andamans), several specimens; Port Blair (South Andamans), several specimens; Mandapam (Gulf of Mannar & Palk Bay), several specimens; Tuticorin (Gulf of Mannar), several specimens; Jamnagar (Gulf of Kutch), two specimens, all specimens collected from the intertidal to 5 metres depth.

Description: The specimens examined varied in length from 30 mm to 400 mm. The body is robust with both the ends blunt. The dorsal side is convex and the ventral side is flat. The skin in large specimens (300-400 mm length) is very thick (10-15 mm) and slimy to touch. On the dorsal side, there are many small papillae which are mainly scattered and often inconspicuous. On the ventral side the pedicels are densely distributed without any arrangement. Each dark spot on the ventral side represents one pedicel.

There are two large polian vesicles and a single stone canal. The calcareous ring is of the usual type. The left respiratory tree is much larger than the right. The paired radial muscles are not in firm contact with the body wall.

The spicules consist of tables and buttons. They differ remarkably in smaller (50 mm in length) and larger (200-350 mm in length). Smaller specimens have buttons (Fig. 4, B), which are large with five pairs of holes in addition to a single hole at each end. All buttons are knobbed. In addition to the buttons, there are also irregular perforated plates. The tables are short and the margins are not quite round. Each table has a few to many holes. The tables are short with a horizontal cross bar and a crown of spines at the top, which are visible in lateral view. In the apical view, eight outwardly pointed spines are seen. In large specimens (Fig. 4, C), the tables are short with a central hole and eight peripheral holes. The spire consists of four vertical bars which terminate in a few spines. There is a tier of cross bars in the spire.

The buttons are small and have generally three pairs of holes. The pedicels have small terminal plates.

Colour in the living condition is grey to black on the dorsal side, and white ventrally. Generally, smaller specimens are totally black and larger specimens have a number of irregular yellow transverse bands on the dorsal side. One specimen was brown.

Notes on habits: This species is characteristic of muddy-sandy regions. and prefers less saline waters. During low tide, a number of them can be seen half buried as the posterior end of the body is always kept outside. Small forms (50 mm to 90 mm in length) are seen to lie freely on the muddy ground during low tide. At some places there are 2-10 juveniles distributed in an area of five square metres. It occurs from the intertidal region to 10 metres depth, but is mostly distributed at depths of 1-5 metres.

A pea crab *Pinnotheres deccanensis* lives inside the cloaca. James (MS) has presented a detailed account on the habits of the association. Chopra (1932) reported the occurrence of this crab inside the same species of holothurian from the Andamans. Jones and Mahadevan (1965) gave an account of this association from the Gulf of Mannar.

I have collected two gastropod parasites *Prostilifer* sp. from this species. It appears to be very rare and forms a gall in the body wall. Only the tip of the shell is seen outside, and when it is touched it is withdrawn. In each gall, only one specimen is found. The parasite is firmly entrenched

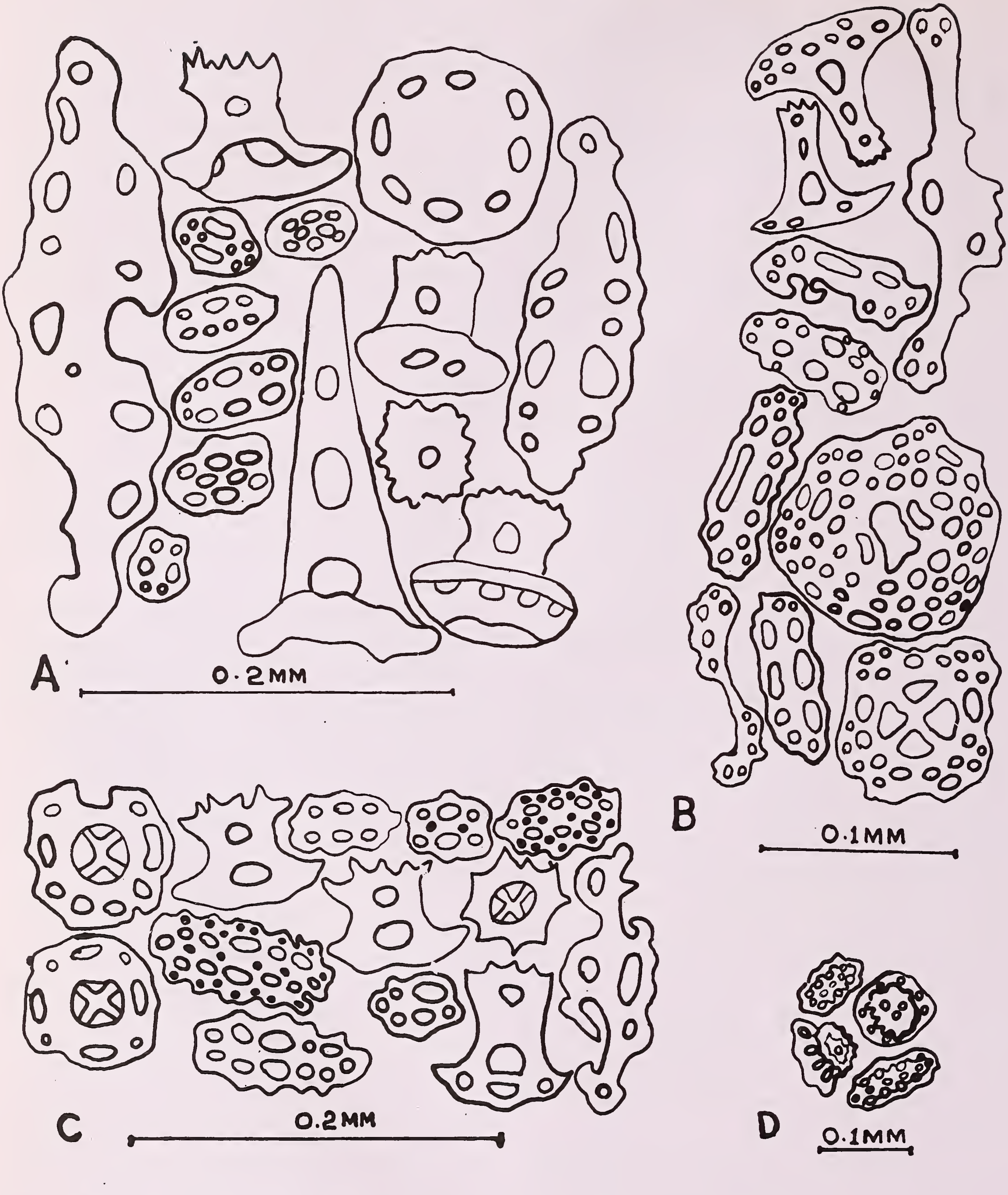


Fig. 4. Spicules of: A. *Holothuria* (*Theelothuria*) *spinifera*; B. *Holothuria* (*Metriatyla*) *scabra* (from juvenile); C. *Holothuria* (*Metriatyla*) *scabra* (from adult); D. *Holothuria* (*Microthele*) *nobilis*.

in the body wall, and can be taken out only by cutting the body wall. Waren (1983) reported *P. subpellucida* from the body wall of *Bohadschia argus* from the Pacific. Usually a male and a female are found together in the same gall.

At Port Blair (Andamans) during February, 1978 a total of 462 juveniles ranging in length from 65 mm, to 160 mm were collected from the intertidal region at South Point. These were transferred to an enclosed place for further growth. After six months, they had grown to a good size.

Remarks: It is surprising that Pearson (1903) describes this well known species as a new species *Holothuria gallensis* from Sri Lanka. This is the most valuable species for processing from India. Fresh specimens cost Rs. 30-50 depending on size and processed material costs Rs. 650.00 to Rs. 700.00 per kg. James (1986e) wrote on the quality improvement of *Bêche-de-mer* James (1973, 1986b, 1987, 1989a, 1989c) and also wrote on the *Bêche-de-mer* from *Holothuria (Metriatyla) scabra* and other species.

James *et al.* (1988), for the first time, succeeded in inducing this holothurian to spawn in the laboratory and produce seed. Now culture and sea ranching of this species is taken up by the C.M.F.R. Institute.

Distribution: Known from the Mascarene Islands, East Africa, Madagascar, Red Sea, S.E. Arabia, Sri Lanka, Gulf of Mannar and Palk Bay, East Indies, North Australia, Philippines, China and South Pacific Islands. This species is not distributed in Lakshadweep. (The distributional record given by James (1986a) from Lakshadweep-Maldives is based on distributional record given by A.M. Clark and Rowe (1971) from Maldives.)

Subgenus *Microthele* Brandt, 1835

Diagnosis: Tentacles 20; pedicels and papillae indistinguishable, scattered ventrally and dorsally, no apparent 'collar' of papillae around the base of the tentacles, anus usually with five calcified papillae only, though in smaller specimens (up to 200 mm long) more papillae may be present, and in very large specimens (over 400 mm long) anal papillae may be entirely lacking; body wall very thick, usually 5 (5-10 mm); body rather cylindrical; size large or even massive, up to 600 mm long; calcareous ring massive, with distinctly scalloped anterior margin, radial and interradial plates squarish, the radials being about twice the length of the interradials; spicules consisting of stout, well developed tables with smooth squarish disc, spire of moderate height, terminating in many small spines, buttons usually always hollow fenestrated ellipsoids though a few simple buttons may be present.

Type-species: *Holothuria (Metriatyla) maculata* Brandt, 1835: 54 = *Muelleria nobilis* Selenka, 1867; designated by A.M. Clark & F.W.E. Rowe, 1967:100). At present, only one species is included under this subgenus.

Holothuria (Microthele) nobilis (Selenka)

(Pl. 2, D; Fig. 4, D)

Mulleria nobilis Selenka, 1867, p. 313: Zanzibar, Sandwich Islands (Hawaiian Islands).

Holothuria maculata Bell, 1887 a, p. 140: Andaman Island.

Holothuria (Microthele) nobilis Price & Reid, 1985, p. 4: Chetlat Island (Lakshadweep); James, 1989a, p. 5: Lakshadweep, Andamans; James, 1989b, p. 128: Chetlat, Kiltan, Kadmat, Amini, Kavaratti, (Lakshadweep); James, 1989c, p. 148: Lakshadweep.

Microthele nobilis A.M. Clark & Davies, 1966, p. 600: Maldives; James, 1969, p. 61: Lakshadweep, James, 1973, p. 707.

Material: Port Blair (South Andamans), one specimen; Chetlat, several specimens; Kadmat, three specimens; Amini, several specimens; Kavaratti, two specimens; Minicoy, one specimen, all collected from the lagoon, depth less than a metre.

Description: The specimens examined varied in length from 250 mm to 400 mm. The body is massive and tubular in shape. Live weight varies from 2 to 3 kg in fresh condition. Body wall is 10-15 mm in thickness. Pedicels and papillae are indistinguishable. Dorsal papillae are more thinly scattered than the ventral pedicels. Anus is surrounded by five calcified papillae. Calcareous ring is massive with distinctly scalloped anterior margin. The radials and interradials are squarish.

Radials are twice the length of the interradials. Tentacular ampullae are very large.

Spicules (Fig. 4, D) consist of tables and buttons. The tables are robust with smooth discs and the spires terminate in 15-20 small spines. The diameter of the table varies from 0.06 mm to 0.08 mm. The disc of the tables is either irregularly rounded or square-shaped. The inner layer has closely packed hollow fenestrated ellipsoids which are 0.07 mm in length. They have four rows of holes. A few simple knobbed buttons are also present.

This species occurs in two colour forms, white and black. At Lakshadweep the colour pattern is as follows. The general colour is black on the dorsal side and white or yellowish white mottled with black or brown on a white background.

Notes on habits: The species lies freely in the lagoon in the adult stage and is often covered with a coating of sand. Young white forms live among the algae. The white form is found in more than 3 m depth of water. It occurs up to 30 metres depth. It is most abundant on clean sand among the reefs. The black form is found in shallow waters from the reef to about a depth of 3 m.

Remarks: The species is very valuable for *bêche-de-mer* preparation. Though abundant in Lakshadweep, it is not processed at present. The white form is said to be more valuable for processing than the black one.

Distribution: It is distributed in the Islands of the Western Indian Ocean, Mascarene Islands, East Africa and Madagascar, Red Sea, Lakshadweep, Maldives, Sri Lanka, Andamans, East Indies, North Australia, Philippines, China, South Pacific Islands and the Hawaiian Islands.

ZOOGEOGRAPHY

The genus *Holothuria* is common and well represented in the seas around India. Of the 18 species of Holothuria collected from the Lakshadweep, west coast of India, east coast of India, Gulf of Mannar and Palk Bay and the Andaman and Nicobar Islands, only one species namely *Holothuria (Semperothuria) cinerascens* was collected from all the five geographic locations mentioned above. Surprisingly, it is not the ubiquitous holothurian *Holothuria (Halodeima) atra* of the Indian Seas. This species needs algal beds for its existence and is found to feed extensively on the calcareous alga *Halimeda* sp. Of the 18 species, 13 were collected from Lakshadweep, 6 from the West Coast of India, 2 from the East Coast of India and 17 from the Andaman and Nicobar Islands. *Holothuria (Theelothuria) spinifera* is not distributed in the Andaman and Nicobar Islands, Lakshadweep and also on the west coast of India. It has a restricted and discontinuous distribution, being known from the Red Sea, Persian Gulf, Gulf of Mannar and Palk Bay, Sri Lanka, North Australia, Philippines and China. James (1983a) reported this species for the first time from Madras (east coast of India). *Holothuria (Metriatyla) scabra,* the most valuable species for *Bêche-de-mer* preparation from India is not distributed in Lakshadweep. James (1986a) listed *Holothuria (Metriatyla) scabra* in the Distributional Table under the region Lakshadweep-Maldives, based on positive record of the specimens in the British Museum (A.M. Clark and Rowe 1971). A.M. Clark and Spencer Davies (1966) state that Gardiner's locality labels were removed while the collections were still in Colombo and the Maldive specimens were mixed up with others from Chagos Archipelago, Seychelles, Amirantes and Red Sea. *Holothuria (Metriatyla) scabra* collected from the Red Sea, Seychelles or other locality would have been given the wrong locality label as Maldives. The papers published on the Maldive echinoderms and a collection of echinoderms from the Maldives examined by the author do not contain this species. To-day *Bêche-de-mer* is a flourishing industry in the Maldives. James and Ali Manikfan (1994) wrote a paper on the *Bêche-de-mer* industry of Maldives in which no mention of the species is made. One of us (AM) examined large samples at Maldives and could not find a single specimen. As a result of a thorough survey, it is certain that it does not occur at Lakshadweep (James 1989b, 1989c). The faunal composition of the two regions is similar and therefore it is safe to conclude that the positive record from the British Museum is based on wrong locality label. The east and west coasts of India are poorly represented by the genus *Holothuria* due to lack of coral reefs. This excludes the Gulf of Mannar and Palk Bay and also the Gulf of Kutch. Intensive collections have not been made from the Gulf of Kutch. The distribution of the species of *Holothuria* from the five regions is given in Table 1.

TABLE 1

DISTRIBUTION OF THE SPECIES OF *Holothuria* FROM INDIAN SEAS

Name of the species	LK	WC	EC	GM&PB	A&N
Holothuria (Acanthotrapeza) pyxis	—	—	—	—	+
Holothuria (Cystipus) rigida	+	—	—	—	+
Holothuria (Halodeima) atra	+	+	—	+	+
Holothuria (Halodeima) edulis	+	—	—	+	+
Holothuria (Lessonothuria) pardalis	+	+	—	+	+
Holothuria (Mertensiothuria) fuscocinerea	+	—	—	—	+
Holothuria (Mertensiothuria) leucospilota	+	+	—	+	+
Holothuria (Mertensiothuria) pervicax	+	—	—	—	+
Holothuria (Metriatyla) scabra	—	+	—	+	+
Holothuria (Microthele) nobilis	+	—	—	—	+
Holothuria (Platyperona) difficilis	+	—	—	—	+
Holothuria (Selenkothuria) erinaceus	—	—	—	—	+
Holothuria (Selenkothuria) moebii	—	+	—	+	+
Holothuria (Semperothuria) cinerascens	+	+	+	+	+
Holothuria (Theelothuria) spinifera	—	—	+	+	—
Holothuria (Thymiosycia) arenicola	+	—	—	—	+
Holothuria (Thymiosycia) hilla	+	—	—	+	+
Holothuria (Thymiosycia) impatiens	+	—	—	—	+

LK-Lakshadweep; WC-west coast; EC-east coast; GM & PB- Gulf of Mannar & Palk Bay; A & N- Andaman & Nicobar Islands.

As a result of my studies, the range of the following species has been extended to the localities noted against them.

Holothuria (Selenkothuria) moebii- Arabian Sea; *Holothuria (Selenkothuria) erinaceus*- Arabian Sea; *Holothuria (Mertensiothuria) leucospilota*- Arabian Sea; *Holothuria (Platyperona) difficilis*- Lakshadweep; *Holothuria (Lessonothuria) pardalis*- Lakshadweep; *Holothuria (Thymiosycia) arenicola*- Lakshadweep; *Holothuria (Thymiosycia) impatiens*- Lakshadweep; *Holothuria (Cystipus) rigida*- Lakshadweep; *Holothuria (Mertensiothuria) pervicax*- Lakshadweep; *Holothuria (Mertensiothuria) fuscocinerea*- Andaman & Nicobar Islands; *Holothuria (Mertensiothuria) pervicax*- Andaman & Nicobar Islands; *Holothuria (Cystipus) rigida*- Andaman & Nicobar Islands.

HABITS OF DIFFERENT SPECIES

The species of the genus *Holothuria* live chiefly among corals as fugitive forms. That is why a good number of species are collected from Lakshadweep Islands, Gulf of Mannar and Palk Bay and Andaman and Nicobar Islands. Rowe (1969) listed surf-zone species, fugitive species and fossorial species. In addition to these three divisions, there are forms which live freely like *Holothuria (Halodeima) atra, Holothuria (Halodeima) edulis* and *Holothuria (Microthele) nobilis.* Table 2 lists the species according to their habit.

From the Table 2, it is seen that fugitive forms are maximum (8 nos.), followed by fossorial forms (5 nos.), free living forms (3 nos.) and surf zone forms (2 nos.). It is also seen that all species belonging to one subgenus do not exhibit the same habit. The same species exhibits different habits at different places. *H. (Halodeima) edulis,* which is a free living form occurring below low-water mark in the Indian seas, is reported to live under stones at Guam by Rowe and Doty (1977). *H. (Selenkothuria) erinaceus,* which is reported to be a surf zone species, is found to be fossorial at Andamans, burying completely in mud. Similarly *H. (Thymiosycia) arenicola* which is listed as fugitive species by Rowe (1969) is truly fossorial at

TABLE 2

LIST OF THE SPECIES UNDER THE GENUS *Holothuria* ACCORDING TO THEIR HABITS

Free living species	Surf zone species	Fugitive species	Fossorial species
H. (H.) atra *H. (H.) edulis* *H. (M.) nobilis*	*H. (S.) moebii* *H.(S.)cinerascens*	*H.(T.) impatiens* *H.(T.) hilla* *H.(M.) pervicax* *H.(M) fuscocinerea* *H.(M.) leucospilota* *H.(L.) pardalis* *H.(A.) pyxis* *H.(P.) difficilis*	*H.(T.) arenicola* *H.(T.) spinifera* *H.(C.) rigida* *H.(M.) scabra* *H.(S.) erinaceus*
3 nos.	2 nos.	8 nos.	5 nos.

Lakshadweep. At times, *H. (Mertensiothuria) leucospilota* occurs along with *H. (Halodeima) atra* as a free living species. *H. (Mertensiothuria) leucospilota* has the habit of tucking its posterior end under rocks, whereas in case of *H. (Acanthotrapeza) pyxis* the posterior end is firmly entrenched among rocks and it is impossible to pull out specimens without damaging them. *H. (Theelothuria) spinifera* buries completely into sand, whereas *H. (Metriatyla) scabra* is partly buried and keeps the posterior end out of sand. Rowe (1969) has listed *Holothuria (Halodeima) atra* and *H. (Microthele) nobilis* as fugitive forms. These species were never encountered under stones in the Indian Seas.

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AUTUMN MIGRATION OF BROAD-BILLED SANDPIPER (*LIMICOLA FALCINELLUS* PONTOPP.) IN KAZAKHSTAN[1]

E.I. Gavrilov[2], A.E. Gavrilov, S.N. Erokhov, V.V. Khrokov[3]

Key words: waders, broad-billed sandpiper, autumn migration, Kazakhstan

Observations in 1975-1985 in Kazakhstan showed that autumn migration of Broad -billed Sandpiper begins in July (mean date is July 18) and lasts up to end of Augsut or middle of September (mean date is September 7). First of all adult birds migrate and juveniles follow them some time later. Differences in migration dates, wing-length and weight of adults and juveniles, males and females are discussed also.

The Broad-billed Sandpiper (*Limicola falcinellus* Pontopp.) is a rare wader species in our fauna. The biology, including breeding and migratory activities is still insufficiently known (Gladkov 1951, Kozlova 1962). As to its autumn migration the Broad-billed Sandpiper was recorded in different regions of Kazakhstan only about 10 times (Dolgushin 1962). Thus data on Broad-billed Sandpiper collected over the last several years are an essential supplement to the available literature.

Investigations on the Broad-billed Sandpiper's autumn migration were conducted in Central Kazakhstan in 1975-1977, namely in reservoirs of the lower reaches of Turgai river (48°28'N, 62°09'E); in Tengiz-Kurgaldjinskaya cavity [Kipshak lake (50°12' N, 68° 24' E) and Tengiz lake (50°32' N, 69°20' E); 1983]; in the overflow of artesian chink near Telikul lake system in the lower reaches of Sarysu river (42° 30' N, 67° 10' E; 1986); in south-eastern part of the republic in 1977-1985, namely in Sorbulak that is a reservoir accumulating sewage in the environs of Alma-Ata (43° 46' N, 76° 05' E); in Sasykkol lake (Balkhash-Alakkol hollow, 46° 41' N, 80° 36' E; 1981).

In July-September birds were trapped with mist nets and "daradanes" of 10-75 m length. Traps were used to determine the number of small waders (Gavrilov 1980). The standard length of a net was 10 m and net used per twenty-four hours was 100.

The age of the captured Broad-billed Sandpipers (total number 376) was determined from the form of tertials feathera apex, its shabby appearance, colour of throat and crop. The maximum wing length was calculated with the help of a stop-ruler. Balance VLTK-500 (accurate to 0.1 g) was used to obtain weight.

Statistical treatment was done on microcalculator Casio fx-39. A number of figures of less than 50 were considered as small selection. Median date of Broad-billed Sandpiper passage was determined when 50% of the birds were captured (Preston 1966).

The arrival of the first Broad-billed Sandpiper in Central and South-Eastern part of Kazakhstan did not differ: in July it was 9-23, mean data of 5 years-July 18 ($\sigma = 6.93$), in July 10-25, mean data of 9 years was July 18 ($\sigma = 5.36$) respectively. On Sorbulak lake over a period of 8 years early migratory activities were observed in 1977, 1979-1981, 1983 (mid July), and late ones — in 1978, 1982 and 1985 (late July), with the variation of their first arrival being 14 days.

The total dynamics of migration is characterized by two passage waves — from mid July till early August, and from mid August till early September (Table 1). This is a result of a considerable difference in the periods of juvenile and adult migratory activities. Adults are initiators of the passage. In Central Kazakhstan median date of their migration - July 22, in south-eastern part-July 27, as a whole for the Republic-July 26. In Central Kazakhstan the last few adults were recorded during July 23-August 15, mean data of 4 years was August 4 ($\sigma = 9.43$), in south-eastern part

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[1] Accepted November 1990.

[2] Animal Marking Centre, Institute of Zoology and Animals, Genetic Fund of NAS RK, Kazakhstan 480032 Almaty, Academgorodok.

[3] Institute of Zoology, National Academy of Sciences of the Kazakhstan Republic.

during July 29-August 26, mean data of 9 years was August 11 (σ= 8.04). In the south-eastern part of the Republic migratory activities of adult Broad-billed Sandpipers usually come to the end in early August, but in 1982, when passage began only in July 23, birds were recorded till August 26, so that in the second half of the month, 8 of them were captured, which represented 72.7% of the total number for the whole year.

Juveniles began their autumn passage a month later than adults. In Central Kazakhstan the first juveniles were captured in August 13-16, mean data of 4 years was August 15 (σ= 2.06), in south-eastern part of the Republic in August 3-22, mean data of 7 years was August 14 (σ= 6.80). Median dates of their passage are August 25 and 26 respectively, as a whole for the Republic-August 25. In Central Kazakhstan the last few Broad-billed Sandpipers were recorded in August 18-September 17, mean data of 4 years was August 29 (σ= 13.25). The data did not correspond to the actual situation, as in 1975, 1976 and 1983 there was no trapping work in September at all. In the Tengiz-Kurgaldjiin a juvenile female was trapped in September 10, 1969. Taking this date into account August 31 is an average date for the end of the passage according to 5 years of investigation (σ= 12.72). In the south-eastern part of the Republic the last few juveniles were recorded in August 22-September 16, mean data of 7 years was September 3 (σ= 9.44). Excluding 1977, 1980 (no trapping work in September), last juveniles were captured in August 29-September 16, average data of 5 years was September 7 (σ= 8.41).

The analysis of the above material showed simultaneous passage movement of Broad-billed Sandpipers across the whole territory of Kazakhstan. As to median dates of juvenile and adult migration, in south-eastern parts they are 5 or 1 day later. Completion of passage in this territory was somewhat later also.

The Broad-billed Sandpiper chicks are cared for by both parents at the beginning, but later on female leaves the brood and only the adult male takes care of the chicks (Cramp and Simmons 1983). There is an assumption that in eastern subspecies of the Broad-billed Sandpiper the female does not take any part either in incubating or in caring for the young (Flint 1973). According to this biological specificity adult females have to acquire their Autumn migratory disposition earlier than the males. In different years adult females were recorded

TABLE 1

AUTUMN MIGRATION DYNAMICS OF BROAD-BILLED SANDPIPER IN KAZAKHSTAN

(BASED ON CAPTURE DATA)

Region	Months															Total
	July					August						September				
	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	
Central																
Ad.	—	10	4	6	6	3	—	1	—	—	—	—	—	—	—	30
Juv.	—	—	—	—	—	—	—	5	15	13	20	3	4	1	1	62
Total	—	10	4	6	6	3	—	6	15	13	20	3	4	1	1	92
South Eastern																
Ad.	1	4	38	35	62	20	17	2	6	2	1	—	—	—	—	188
Juv.	—	—	—	—	—	1	1	5	18	22	33	11	3	1	1	96
Total	1	4	38	35	62	21	18	7	24	24	34	11	3	1	1	284

in July 16-August 6, average date was July 23 (n = 3; σ = 12.12), adult males in July 20-August 16, average date was July 30 (n = 5; σ = 10.48). Sexual dimorphism is clearly expressed in Broad-billed Sandpiper's size and females have a longer wing span than males (Cramp and Simmons 1983). We have analysed changes in wing length throughout the season. Mean maxima of wing length for adults in Sorbulak lake (1980-1985) in July was 107.4 mm (n=40; σ = 2.24) in August 106.2 mm (n=22; σ = 2.05). Average weight for adult males was 32.6 g (n = 4; σ = 6.04), for adult females 37.5 g (n=2; σ = 6.93). In the first half period of migration (till July 26) average weight figures of adults in Sorbulak lake was 38.3 g (n=90; σ = 5.61), later on 37.9 g (n=81; σ = 5.72). Though differences in wing length and weight in different periods of migration are statistically doubtful, reduction of these parameters show a slight prevalence of males over females in the second half of their passage.

Among juveniles males were recorded during August 3-September 10, average date was August 26 (n=7; σ = 13.37), females during August 13 - Septemebr 13, average date was September 1 (n=12; σ = 9.65). As juvenile females are larger than males (Cramp and Simmons 1983), we have analysed seasonal changes of average wing length in birds captured on Sorbulak lake (1980-1985). In the 2nd and 3rd weeks of August it was 106.7 and 106.6, in September — 106.6 mm (n=14,14 and 5; σ = 3.07 2.65 and 1.82 respectively), i.e. were identical. In the lower reaches of Sarysu river (1986) juveniles were seen in August 13 — September 17; in August 19-23 there was no birds at all. The average maximum wing length recorded till August 18 was 108.4 mm (n=7; σ = 2.94), later on 106.5 mm (n=35; σ = 3.17); birds captured in September it was 106.5 mm (n=9; σ = 3.24). Due to this data juveniles (as also adults) with short wing length (presumably male) were more frequent at the end

TABLE 2

GEOGRAPHICAL VARIATIONS OF WING LENGTH AND MASS FIGURES IN BROAD-BILLED SANDPIPERS IN KAZAKHSTAN

Region in Kazakhstan 1	Age 2	limits 3	M ± m 4	σ 5	n 6
		wing length, mm			
Central	Adults	100-112	106.1±0.7116	3.0190	18
South-eastern	Adults	102-113	106.95±0.2798	2.2028	62
Total	Adults	100-113	106.8±0.2701	2.4161	80
Central	Juveniles	98-113	106.9±0.4236	2.9950	50
South-eastern	Juveniles	102-113	106.6±0.4643	2.6671	33
Total	Juveniles	98-113	106.8±0.3136	2.8571	83
		weight, g			
Central	Adults	26.0-46.3	34.4±1.0420	5.7075	30
South-eastern	Adults	23.6-52.1	38.2±0.4333	5.6656	171
Total	Adults	23.6-52.1	37.6±0.4100	5.8132	201
Central	Juveniles	22.0-54.4	35.7±0.9181	6.9308	57
South-eastern	Juveniles	22.5-45.4	33.1±0.4817	4.7198	96
Total	Juveniles	22.0-54.4	34.1±0.4676	5.7842	153

of their migratory activity, though average dates of male and female records did not coincide with these data.

Our investigations showed that in the juvenile female weight figures were larger than in males. For females 24.4-38.7 in average 35.4 g (n=12; σ = 4.53); for males 22.0-37.2, average 30.1 g, (n=7; σ = 5.20). On Sorbulak lake through the first half of the migratory period (till August 26) average weight of juveniles was 32.8 g (n=57; σ = 4.76) and later on — 33.6 g (n=39; σ = 4.68); in the low reaches of Sarysu river it was 33.9 g (n=15; σ = 6.00) and 38.7 g (n=27; σ = 7.15) respectively.

Thus adult males start migrating somewhat later than the females as is clear from average dates of migration and decreasing of average wing length and weight of birds to the end of their migration. Differences in migratory dates are not large, to ensure that females take part in caring for chicks. For juveniles, there is no clear picture. On certain dates females make their passage later than the males, increase of average migratory mass in the second half of migration is a confirmation of it; wing length figures do not change or decrease. For the last case it means prevalence of males over females. It is necessary to stress that weight figures are not a reliable index of male or female prevalence, as is defined by the physiological state of a bird (by amount of fat storage).

Population differences are not clearly expressed in Broad-billed Sandpipers passing across Central and South-Eastern Kazakhstan (Table 2). In both age groups differences in average wing length in these regions was less than 1 mm. Differences in weight were not equal, in the south-eastern part of the Republic they were larger for adults by 3.8 g; in Central Kazakhstan for juveniles by 2.6 g. Perhaps, it is connected with variations of food storage in these regions, and also with differences in migratory strategy.

Average weight figures of adults compared to juveniles in different years showed that juveniles had annual weight 1.2-8.7 g less than adults (Sorbulak lake); in the low reaches of Sarysu river such figures comprised 0.5 g, in Kurgaldjiin lakes juvenile's weight exceeded adult's by 1.4 g (Table 3).

On Sorbulak lake during the period of 1977-1985 out of 264 Broad-billed Sandpipers 39 (14.8%) were recaptured. From 164 adults, 17 (10.4%) had breaks in their passage, from 100 juveniles, 22 (22.0%) had done so, an average duration of such breaks form 10.1 and 6.5 days respectively. In Central Kazakhstan (1975-1986) out of 87 Broad-billed Sandpipers 14 (16.1%) were recaptured. From 30 adults, 6 (20.0%) had breaks in their

TABLE 3

CHANGES IN AVERAGE WEIGHT FIGURES OF ADULT AND JUVENILE BROAD-BILLED SANDPIPER FOR SEVERAL YEARS DURING THEIR AUTUMN MIGRATION IN KAZAKHSTAN

Locality	Year	Adults			Juveniles		
		M	σ	n	M	σ	n
Sorbulak lake	1977	38.6	6.0021	36	31.3	4.5596	4
	1978	38.0	5.4360	27	32.7	3.0807	26
	1979	40.5	5.2569	43	34.7	4.6217	33
	1980	36.9	4.9852	17	30.4	4.5608	10
	1981	34.9	5.1753	25	26.2	3.0501	3
	1982	36.1	6.3977	11	34.9	6.1043	9
	1983	38.5	5.2123	7	—	—	—
	1985	41.7	5.3740	2	32.3	5.6388	11
Lower reaches of Sarysu river	1986	37.5	8.1540	5	37.0	7.0719	42
Kurgaldjino	1983	32.9	4.3771	13	34.3	3.9206	8

TABLE 4

CHANGES IN WEIGHT FIGURES IN RECAPTURED BROAD-BILLED SANDPIPER IN KAZAKHSTAN DUE TO BREAK IN PASS AGE

	Breaks (days)				
	1-3	4-6	7-10	11-15	16-31
Weight increases	5	9	5	6	6
Weight decreases	13	6	3	5	5
Average weight change, g	-1.3	+1.8	+3.3	+2.3	+3.1
Number of data	18	15	8	11	11

passage, and from 57 juveniles, 8 (14.0%) had stayed an average duration of 2.5 and 12.4 days respectively.

The change in weight in resting Broad-billed Sandpipers varied according to the duration of their resting time (Table 4). During the short period of time after trapping (up to 3 days) the birds (72.2%) showed decrease in their weight, being in mean 1.3 g for every bird. Such a phenomenon is a characteristic for many species being a result of stresses the birds are exposed to in captivity. Prolonged resting time led to a total increase of weight, and some individuals showed excellent ability to fat accumulation. In a 4 day period their weight increased by 6.7 g, in 5 days- 9.4 g, in 6-10.4, in 9-15.9, in 15-15.4, in 19-17.2 g.

Accumulation of stored fat during the resting period up to 10 days averaged 0.3-1.8 g/twentyfour hours, and for more than 10 days 0.4-0.9 g/twenty-four hours. The decrease of weight was sometimes recorded during a period of long rest, and could be explained by physical traumas of birds in mist-nets (injury of wing, foot) that disturb their vital activity. On Sorbulak lake under conditions of positive weight balance, mean weight of 7 adults during their resting time increased from 35.8 to 41.3 g (15.4%) in 11 juveniles from 33.5 to 40.7 g (21.5%), in the lower reaches of Sarysu river for 6 juveniles from 30.2 to 38.8 (28.5%). In the last case mean weight of juveniles, captured during the same period of time, but without recaptures, was 38.0 g (n=22; σ = 6.28), i.e. practically similar to birds which had accumulated stored fat during their resting time. As a rule birds with less weight stopped their passage for a resting period, though there were exceptions. Thus in August a captured juvenile weighed 37.2 g and after 9 days 53.1 g; a juvenile caught in August 21 weighed 43.1 g, and after 5 days 52.5 g.

The Broad-billed Sandpiper is low in numbers everywhere in Kazakhstan. In reservoirs of Central Kazakhstan they comprised in different years 0.27-2.26, on an average 1.39 birds for 100 nets/twenty four hours; in the south-eastern part up to 6.28, and an average 2.43 birds for 100 nets/twentyfour hours. The largest change in number was noted in Sorbulak lakes. In the first years of the lake's formation there was a considerable number of Broad-billed Sandpipers. Beginning from 1980 a progressive decrease in the number of resting birds was noted (coinciding with decrease of average weight in adults and juveniles). In 1984 none of the Broad-billed Sandpiper were met, though from 1985 they began to stop there again. Marked variations in number were connected with changes of ecological situation, and as a result changes in food storage. In the whole of the south-eastern part of the Republic Broad-billed Sandpiper's number was 1.75 more than in the central part.

Usually Broad-billed Sandpiper had 4, rarely 3 eggs in its clutch in a year. The number of lost nests and fledged chicks are not known (Cramp and Simmons 1983). In our material (Table 5) age ratio (adults and juveniles) during the period of their passage along the lower reaches of Turgai river and Kurgaldjino, was 1:0.76 (capture was done only in July and August). In the lower reaches of Sarysu river it was 1:8.6. In total in reservoirs of Central Kazakhstan for one adult 2.07 juveniles were captured, which exceeds the natural fecundity of the Broad-billed Sandpiper. During many years adults were seen on Sorbulak lake though capture activity continued till October. In 1978-1979 adults and juveniles migrated in good numbers and age-ratio was 1:0.84. On the whole the age-ratio was 1:0.51 in the south-eastern part of the Republic.

The Broad-billed Sandpipers migrate in a wide front in Autumn across the land and concentrated flyways are lacking (Cramp and Simmons 1983). Only in Crimea flocks of up to some hundreds of birds were recorded (Kostin 1983). Usually solitary birds, small groups of flocks comprising 20-30 birds were observed. That is why the assumption that age ratio in Autumn migration reflects their fecundity, is correct. In this case low breeding level was observed in 1977, 1981, 1983, and high one in 1978, 1989, 1985. Perhaps it is breeding success that resulted in number variations of Broad-billed Sandpiper during their Autumn passage as recorded by several authors (Nankinov 1985). At the same time a great number of juveniles, caught in 1986 in the lower reaches of Sarysu river in Telikyl lakes when the median date of their migration was August 26, leads to the supposition that a concentrated stream of juveniles pass in some years through this region.

TABLE 5

NUMBER AND CORRELATION OF AGE GROUPS OF BROAD-BILLED SANDPIPER DURING THE AUTUMN MIGRATION IN DIFFERENT REGIONS OF KAZAKHSTAN

Locality	Year	Number of nets/ 24 hours	Birds caught	Number on 100 net/24 hours	Captured	
					Ad.	Juv.
Lower reaches of Turgai river	1975	480	8	1.67	4	4
	1976	618	14	2.26	7	7
	1977	374	1	0.27	1	0
Kurgaldjino, Kipshak lake	1983	1153	21	1.82	13	8
Lower reaches of Sarysu river	1986	3983	48	1.21	5	43
Central Kazakhstan		6608	82	1.39	30	62
Sorbulak Lake (Alma-Ata region)	1977	759	40	5.27	36	4
	1978	1089	53	4.87	27	26
	1979	1209	76	6.29	43	33
	1980	788	28	3.55	18	10
	1981	1251	28	2.24	25	2
	1982	1828	20	1.09	11	9
	1983	1055	7	0.66	7	0
	1984	1598	0	0	0	0
	1985	1392	14	1.01	3	11
Sassykkol lake	1981	?	18	?	18	0
South-eastern Kazakhstan		10969	266	2.43	188	96

The prevalence of adults in their Autumn passage in south-eastern Kazakhstan and juveniles in Central part, taking into account a month difference in the period of their migration may be explained as under. In July, when adults migrate, feeding conditions are more favourable in South-eastern Kazakhstan and Broad-billed Sandpipers increase their resting time, increase in weight and the probability of catching them in mist-nets increased. Analogical situation can be observed in Central Kazakhstan (August), when juveniles pass, resulting in high capture figures. As differences in resting time of adults and juveniles can be compared, we can suppose that they average a total number of different age groups captured in Kazakhstan. The total age-ratio being 1:0.72 in Kazakhstan (218 adults and 158 juveniles) correlates average fecundity of species, i.e. one pair of adults to 1.5 juveniles surviving in Autumn.

The migratory route of the Broad-billed Sandpipers passing through Kazakhstan is not known. Of the 366 ringed birds there were 3 return. From adults ringed on Sorbulak lake in July 30, 1979, one was recovered here in July 10, 1980, another in Sassykkol lake (Balkhash-Alakkoul Hollow) in July 29, 1981, 505 kilometres from the ringing site. One more adult Broad-billed Sandpiper ringed on Sorbulak lake in July 18, 1983 was captured here on August 18, 1985. These indicate constant route of migration of some birds and confirm their passage to their winter breeding places round Tian-Shan range system, that is a characteristic for many species of birds in this region of Kazakhstan.

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A CONCISE REVIEW OF FOREST FLORA OF KERALA[1]

T.S. NAYAR[2]

Key words: history, phytogeography, vegetation, endemism, affinity

Forest flora of Kerala is reviewed in the light of existing literature and occasional forest surveys carried out between 1984 and 1990. History of earlier botanical studies, phytogeography and vegetation, significance of the flora and its affinity with other floristic regions are discussed. The floristic diversity and status of endemic, rare and threatened species in Kerala are also examined.

The hilly state of Kerala which lies isolated from the Deccan Plateau by the mountainous belt of the Western Ghats occupies a geographical area of 38,864 sq.km. The State is, in fact, a narrow strip, 32 to 120 km in width stretching for about 565 km along the Malabar Coast on the western side of the peninsular India.

The State can be divided longitudinally into three geographical zones—Highlands, Midlands and Lowlands. Highlands exceed altitude of 900 m in the Western Ghats with numerous peaks, some well over 1850 m, the highest being Anaimudi, at 2680 m. Midlands lie between the mountains and the plains of the coastal region and are chiefly constituted by undulating hills and valleys. Lowlands, the coastal area, comprise river deltas, backwaters and the shores of the Arabian Sea.

When Kerala was inhabited for the first time, the population might have primarily been concentrated along the coast or scattered along the principal river banks. The rest of the land, in all probability, must have been a wilderness of trees. This primeval of forest was gradually but thoroughly modified by human activities and domesticated animals. Shifting cultivation, intensive grazing, extensive plantations, rapid urbanization as well as industrialization and more over, massive explosion of population over about five thousand years devastated the rich forest cover almost entirely from the Lowlands, much from the Midlands and to an extent even from the Highlands.

Highlands and Midlands harbour the principal forests of Kerala today. Midlands are the areas of intensive cultivation too for cash crops such as cardamom and rubber. Lowlands, however, are now essentially the land of coconut and rice. Forests in Kerala are presently estimated to cover 24% (9345 sq. km) of its total geographical area (Anonymous 1990) and of these, closed forests occupy only 17% (6609 sq. km) (Chandrasekharan *et al.* 1984); the remaining is estimated to represent open or degraded forest land.

1. History of earlier botanical studies: A land of spices, Kerala had been a trade centre for these commodities, especially black pepper, cardamom, cinnamom and ginger. Since 3000 B.C. Assyrians, Egyptians, Greeks, Arabs and afterwards Europeans had come to this land lured by spices. But it was Heinrich van Rheede, the Dutch Governor at Cochin, who took interest in the luxuriant vegetation of the State and published a monumental work on the plants of Malabar 'Hortus Malabaricus' between 1678 and 1703 in 12 volumes illustrated with the assistance of local artists. He described 742 plants.

From 1872 to 1897 Hooker published a comprehensive flora of British India in 7 volumes helped by leading botanists of the time. Hooker's work referred to many places and plants from Kerala. 'A Manual of Malabar District' by William Logan published in 1887 has included descriptions of forests and forest trees of British Malabar. Bourdillon, the then Forest Conservator, wrote in

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[1] Accepted June 1992.

[2] Tropical Botanic Garden and Research Institute, Karimancode, Pacha-Palode 695562, Thiruvananthapuram Dist., Kerala.

1893 'Reports on the forests of Travancore' after combing and crisscrossing 11,200 km of Travancore forests. He described the vegetation keeping rivers as the basis and dealt with nature and biotic relationship of forests in the light of historical facts. This helped him later to publish the book 'Forest trees of Travancore' in 1908. 'Flowering Plants of Travancore', another work published in 1914 by Rama Rao, the then Conservator of Forests, is also a significant contribution to the botany of southern Kerala.

In 1915 Gamble, an English botanist, started publishing 'Flora of the Madras Presidency' and this serial was completed by Fischer in 1936. The work covered many forest areas within the present political boundary of Kerala. Other works which deserve mention are the series of papers published on ecology of Kerala forest (Chandrasekharan 1962), Flora of Calicut (Manilal and Sivarajan 1982), Plantation and Agri-Horticultural Resources of Kerala (Nair 1984a), Economic Botany of Kerala (Nair 1984b), Kerala Forest through Centuries (Karunakaran 1985), Forest Plants of Kerala (Nair and Nair 1985), Study on wet evergreen forests of the Western Ghats (Pascal 1988) and Flora of Silent Valley (Manilal 1988). The revisonary attempt made by Nicolson *et al.* (1988) in establishing the correct identity of plants mentioned in 'Hortus Malabaricus' is a noteworthy contribution to the floristic study of Kerala in particular and to taxonomy in general. Van Rheede's illustrations in 'Hortus Malabaricus' are the types of many Linnean genera and species.

Presently the Coimbatore based regional circle of the Botanical Survey of India is engaged in the exploration of the forest flora of some districts of Kerala; Kerala Forest Research Institute, Tropical Botanic Garden, French Institute of Pondicherry, Department of Botany, Calicut University and Botany Departments of a few colleges in the State are also active in this and related fields.

2. Phytogeography and Vegetation: The Vegetation of India has been phytogeographically analysed and divided into several botanical provinces based on criteria like species-content of the families (Clarke 1898, Hooker 1907), humidity or dryness (Prain 1903) and the distribution of endemic species (Chatterjee 1940). Kerala comes under the 'Malabar' botanical province (India aquosa of Prain, l.c.) which extends along the western side of peninsular India through the humid tropical belt of mountain ranges in the Western Ghats from the river Tapti in South Gujarat to Kanyakumari in Tamil Nadu.

Adjacent to 'Malabar' is the botanical province 'Deccan'. The 'Malabar' flora gradually merges through the leeward side of the Western Ghats with the floristic components of 'Deccan'. Though there exists no clear-cut boundaries between these provinces, Hooker (1907) observed that the most distinctive characteristics of 'Malabar' flora, in contrast to that of 'Deccan', are primarily the occurrence of species belonging to Arecaceae, Bambusaceae, Clusiaceae, Dipterocarpaceae and Myristicaçeae and secondarily the abundance in species of Malayan character, especially plants belonging to the families Anacardiaceae, Araceae, Gesneriaceae, Melastomataceae, Meliaceae, Myrtaceae, Orchidaceae, Piperaceae, Tiliaceae and Zingiberaceae.

Another outstanding feature of 'Malabar' botanical province is the development of tropical rain forests in the Western Ghats especially on the windward side of the southern Ghats between 500 to 1500 m. (Subramanyam and Nayar 1974).

3. Forest Types: The vegetational luxury of Kerala and its unusual wealth of variety, unique for so small a region, are mainly due to the diverse range in altitude and the resultant variation in rainfall, temperature and humidity. Based on these factors, forests in Kerala are brought mainly under 3 types: 1. *Wet Evergreen (rain) Forests,* 2. *Moist Deciduous Forests* and 3. *Dry Deciduous Forests* (Ayyar 1932, Champion 1936, Chandrasekharan 1962, Subramanyam and Nayar 1974, Pascal 1988). In the hills exceeding 1500m, Meher-Homji (1967, 1969, 1984, 1985, 1987-88) has recognised (1) *Shola (tropical montane forest),* (2) *Trees and Shrubs zone at the fringe of the Shola,* (3) *Shrub-Savanna* and (4) *Grassland. Myristica* swamps described by Krishnamoorthy (1960) and Chandrasekharan (1962) are of sporadic occurrence in the State and are very rare today.

Physical features and physiographic as well as biotic factors intervene in determining and modifying the natural vegetation and Kerala is no exception. Classifying the forests which are always dynamic into various types is only an attempt to define the more stable communities based on ecological concepts. Intergrading of different types with various combinations of ecotones is a natural phenomenon. To quote Champion (1936) "it is difficult to classify vegetation in general and of tropical countries in particular."

4. Affinities of the flora: The Indian subcontinent was part of the Gondwana land and the past connections of peninsular India with the now separated continents have been phytogeographically proved through the occurrence of various genera like *Acrotrema* (Dilleniaceae), *Hydnocarpus* (Flacourtiaceae), *Laurembergia* (Haloragaceae), *Hernandia* (Hernandaceae), *Apodytes, Gomphandra, Nothapodytes* and *Sarcostigma* (Icacinaceae) (Nayar 1980b). *Poeciloneuron* (Clusiaceae), now assigned to Bonnetiaceae, occurring in the Western Ghats has many allied genera in South America (Nayar 1977).

Genera like *Poeciloneuron* (Clusiaceae), *Acrotrema* (Dilleniaceae), *Hydnocarpus* (Flacourtiaceae), *Gomphandra, Nothapodytes, Sarcostigma* (Icacinaceae) and *Pittosporum* (Pittosporaceae) occur in the Forests of Kerala and are the characteristic components of the vegetation. *Dorstenia indica* Wall. (Moraceae) occurring in the Western Ghats including Kerala has its counterparts in *D. asteriscus* Engl. in Tropical Africa and *D. radiata* Lam. of Arabia (Corner 1981). Abraham and Vatsala (1981) enumerated 10 genera of Orchidaceae, namely *Acampe, Bulbophyllum, Disperis, Eulopia, Habenaria, Liparis, Nervilia, Oberonia, Satyrium* and *Vanilla* as of common occurrence in the Western Ghats and Africa. All these genera, except *Satyrium,* are well represented in Kerala. 15 species of bryophytes are of common occurrence in peninsular India and East Africa (Schuster 1976).

The flora of the Western Ghats in Kerala holds substantial phytological affinity with the Malaysian region (Hooker 1907, Subramanyam and Nayar 1974). The recent finding by Mohanan and Nair (1981) that Malaysian genus *Kunstleria* (Fabaceae) is represented in Kerala by the species *K. keralensis* Mohanan and Nair also adds to the above observations.

The flora of Kerala presents striking similarity with that of Sri Lanka. *Dorstenia indica* Wall. (Moraceae) which is part of the *Dorstenia* complex occurring in Arabia and Africa is present both in Kerala and Sri Lanka; the monotypic *Kendrickia walkeri* Hook. f. (Melastomataceae) present in Anaimudi and Adam's peak, the highest peaks in Kerala and Sri Lanka respectively also stressess this similarity (Subramanyam and Nayar 1974). The Indo-Sri Lanka genus *Humboldtia* (Caesalpiniaceae), is represented in Kerala by *H. bourdillonii* Prain, *H. decurrens* Bedd. ex Oliver and *H. unijuga* Bedd., *Thrixspermum pulchellum* (Thw.) Schltr. (Orchidaceae), recently reported from Palode forest of Trivandrum district, is earlier recorded only from Sri Lanka (Sathishkumar 1986a). *Huperzia ceylancia* (Spr.) Trev., *H. vernicosa* (Hook. et Grev.) Trev. and *Diphasiastrum wightianum* (Wall. ex Hook. et Grev.) Holub. (Licopodiaceae) occur only in Sri Lanka apart from Kerala and Tamil Nadu (Nair *et al.* 1988). Ramachandran and Nair (1988) have enumerated a number of species common to both Cannanore district of Kerala and Sri Lanka. the occurrence of 'Patenas' in Sri Lanka and montane grasslands in Kerala at the same elevation also manifests the vegetational resemblance between these two countries. Mohanan (1981) is of the opinion that the flora of Quilon district combines the floristic elements of Malabar and Sri Lanka. Then there are species like *Leea indica* (Burm. f.) Merr. (Leeaceae) frequently seen in the forests of Kerala and rest of Peninsular India, that are also common in Australia.

It is evident that the floristic diversity of Kerala like that of the Western Ghats is of an ancient lineage. Such an ancient flora is not just a reservoir of botanical antiques but is a dynamic biological source where speciation is taking place at an accelerated speed (Ashton 1977).

Of about 15,000 species of flowering plants estimated to occur in India, about 4000 are found in the Western Ghats (Nair and Daniel 1986). Available botanical evidence suggests that the State of Kerala is phytogeographically an integral part of the Western Ghats which shares its endemics with the State.

Bourdillon (1893) dealt with 582 indigenous trees from Travancore alone. Rama Rao (1914) recorded 3535 flowering plants from Travancore though he did not claim that his work was wholly based on exploratory surveys. Manilal and Sivarajan (1982) surveyed Calicut district and recorded 983 angiosperms from the area. Exploration of 39,100 ha in and around Silent Valley (Palghat district) has produced over 1,300 species of angiosperms (Nair and Daniel 1986). Vajravelu (1987) reported 1208 angiosperm species from Palghat district but later increased the number to 1355 (1990). Subramanian *et al.* (1987) recorded 757 arborescent species from Palghat forest division which comprised of Palghat and Perinthalmanna talukas of Palghat district and Ernad taluka of Calicut district. Manilal (1988) reported 966 angiosperm species from Silent Valley. Mohanan (1981) recorded 700 flowering plants from Trivandrum district. Though Ramachandran (1981) initially estimated that Cannanore district has 825 angiosperm species, Ramachandran and Nair (1988) recorded 1132 species from the district. An exploratory study of Kerala grasses has revealed that the State has 296 species of Poaceae inclusive of 2 new genera and 26 new species (excluding Bambuseae) (Sree Kumar and Nair 1991). 742 plants illustrated and described by Van Rheede, according to Nicolson *et al.* (1988), represent 690 taxa. Of these, 660 species were collected by them again in and around their original locations, i.e. the erstwhile Cochin State. It can be estimated that the whole state, when exhaustively explored, may have well over 4,000 angiosperm species.

As for the other groups of plants, common gymnosperms represented in the forests are *Cycas circinalis* L. (Cycadaceae) and *Gnetum ula* Brogn. (Gnetaceae); *Gnetum contractum* Markg. is of very rare occurrence in the State. *Decussocarpus wallichianus* (Presl) Laub. (Podocarpaceae) has been recorded at Kochu Pamba beyond Anathode and sporadically within the nearby Goodrical reserve forests in Pathanamthitta district (Chand Basha, KFRI-personal communication). It also occurs at Agastyar Hills, but within the boundary of Tamil Nadu state. No serious work has been published on the pteridophytic flora of Kerala except the first of the envisaged three parts by Nair and his associates (1988). The work is based on explorations conducted in the State between 1968 and 1983. They classified the pteridophytic vegetation on physiographic basis as belonging to 1. Coastal zone, 2. Middle zone and 3. Eastern mountainous zone and enumerated characteristic species of these zones. Ferns and fern-allies of Kerala representing 33 pteridophytic families have been accounted and Kerala has a very rich fern flora.

A lone exploration in Silent Valley itself has resulted in recording 78 species of ferns including one new species of *Pteris* (Aspidiaceae) (Vohra *et al.* 1982). About 55 species of bryophytes have been collected from the recently formed Idukki district and of these 14 taxa are additions to South India (Rajeevan 1985). Vohra *et al.* (1982) have reported 83 species including 3 new species of bryophytes from the Silent Valley.

5. Endemic, rare and threatened flora: Endemic plants are the taxa which enjoy very restricted distribution because of geographical and/or ecological barriers. Peninsular regions are almsot identical to islands in having conditions that favour endemism (Turril 1964). Blasco (1970) observed that South Indian hill tops are rich in endemic species. But historically the flora of peninsular India is impoverished due to the flow of deccan lava during the Cretaceous-Eocene and the spread of aridity in the Neocene and the Quaternary which resulted in the depletion of her characteristic flora leaving a few relic endemic taxa in the region (Nayar 1980a). According to Nayar (1980b) 56 genera and about 2,100 species of flowering plants of peninsular India, most of them confined to the Western Ghats, are endemic.

Though, as earlier stated, phytogeographically the State shares its endemism with the Western Ghats, a number of new species of angiosperms have been recorded from Kerala, especially of late and most of them are not reported from anywhere else in the Western Ghats. This may be due to the fact that the species are niche-specific. Such new species include *Lagenandra nairii* Ramam. & Rajan (Araceae), *Tylophora subramanii* Henry (Asclepiadaceae), *Euphorbia santapaui* Henry (Euphorbiaceae), *Zornia quilonensis* Ravi (Fabaceae), *Laurembergia agastyamalayana* Henry (Holaragidaceae), *Luisia abrahamii* Vatsala, *Oberonia bisaccata* Manilal & Sathish, *Trias bonaccordensis* Sathish, *Cheirostylis seidenfadeniana* Sathish and Rasm. (Orchidaceae), *Dimeria keralae* N.C. Nair, Sreekumar & V.J.Nair (Poaceae), *Dicraea filifolia* Ramam. & Joseph

(Podostemaceae), *Hedyotis gamblei* Henry & Subr., *Psychotria sekharana* (Ramam. & Rajan (Rubiaceae) and many others.

Endemic genera of Kerala are *Kanjarum* (*K. palghatensis* Ramam., Acanthaceae), *Janakia* (*J. arayalpatra* Joseph & Chandr., Asclepiadaceae), *Oianthus* (*O. beddomei* Hook. f., Asclepiadaceae), *Haplothismia* (*H. exannulata* Airy Shaw, Burmanniaceae), *Meteoromyrtus* (*M. wynaadensis* (Bedd.) Gamble, Myrtaceae), and *Limnopoa* (*L. meeboldii* (Fisch.) Hubb.), *Chandrasekharania* (*C. keralensis* V.J. Nair *et al.*) and *Silentvalleya* (*S. nairii* V.J. Nair *et al.*) (all Poaceae).

Some genera having their endemic species in Kerala include *Humboldtia bourdillonii* Prain (Caesalpiniaceae), *Erythropalum populifolium* Mast. (Erythropalaceae), *Pseudoglochidion anamalayanum* Gamble (Euphorbiaceae), *Inga cynometroides* Bedd. (Mimosaceae), *Antistrophe serratifolia* Hook. f. (Myrsinaceae), *Myxopyrum smilacifolium* Bl. (Oleaceae), *Cymbopogon travancorensis* Bor (Poaceae), *Octotropics travancorica* Bedd. (Rubiaceae) (Subramanyam & Nayar 1974), *Blepharistemma membranifolia* (Miq.) Ding Hou (Rhizophoraceae) (Mohanan 1981), *Dalbergia beddomei* Thoth., *D. travancorica* Thoth. (Fabaceae) (Nair 1986), *Brachycorythis splendida* Summerh., *Diplocentrum congestum* Wt. and *Paphiopedilum druryi* (Bedd.) Stein (Orchidaceae) (Sathishkumar 1986b). Further plant explorations of under explored and unexplored vegetational pockets of the State are likely to result in increase in the number of endemic and/or new taxa of Kerala; it is also likely that intensive and extensive floristic explorations of the Western Ghats may reveal the presence of some of the taxa presently endemic to Kerala in other regions of the Western Ghats.

Since endemic plants enjoy restricted distribution they become extinct when their natural habitats are destroyed. Biotic interference and deforestation have made even many a non-endemic species extinct. According to Raven (1977) about 63.3% of the tropical rain forests in India, Burma and Sri Lanka have been destroyed for human use up to 1975.

In Kerala the condition appears equally grave. About 3,500 sq. km of forest lands were transformed into non-forestry purpose between 1950-1970 (Nair and Daniel 1986). This is apart from the destruction of natural forest for 'productive purposes' like plantations of tea, coffee, rubber and various other intentions including monoculturing of economically important exotic tree like *Eucalyptus*. Over exploitation of plants from the forest for use in the indigenous systems of medicine also accelerates the process of destruction of individual species.

Coscinium fenestratum Colebr. (Menispermaceae), once a common species in the forests of Kerala, is a good example to substantiate this assertion. More than 500 species of plants with high medicinal value have been recorded from the State (Anonymous 1981, Nambiar *et al.* 1985). Construction of small as well as big dams is another factor which destroys vast areas of forest. Destruction of forest at such an alarming rate has destroyed the habitats of many species which are endemic or niche-specific.

We do not have a clear account of endemic, rare or threatened flora as our knowledge on Indian flora is still not exhaustive. This is because many parts of Indian forests even now remain underexplored or totally unexplored. As for the Western Ghats, an essay based on available literature shows that about 700 species of flowering plants, most of them endemic or niche-specific, are reportedly rare or threatened (Henry *et al.* 1979, Jain and Sastry 1980, Raghavan and Singh 1983, Vajravelu and Daniel 1983). Out of 38 species described by Beddome from Anaimalai, only five species could be collected by the latter explorers till now and the rest 33 are known only by the type collections (Raghavan and Singh 1983). In all possibility, they might have become extinct due to habitat destruction. *Paphiopedilum druryi* (Bedd.) Stein (Orchidaceae) described from Agastyamala is now considered to be extinct as it could not be relocated afterwards with the sole exception of the report made by Mammen and Mammen in 1974.[3] Kammathy (1983) observed that most of the Commelinaceae species occurring at Agastyar hills are endemic, rare or threatened. Sivadasan (1983) pointed out that about 18 species of Araceae in peninsular India are extremely rare because of the destruction of their habitats. It has been shown that the type locality of *Haplothismia exannulata* Airy Shaw (Burmanniaceae) has been submerged due to the construction of Parambikkulam Dam (Ramamurthy and Chandrasekharan 1981). *Asplenium grevillei* Wall. ex Hook. et Grev. (Aspleniaceae), a very rare and threatened species of fern occurring in association with the *Myristica* swamp at Kulathupuzha in Quilon district until 1979 could not be located afterwards and subsequently disappeared from the locality as the swamp was drained and the trees removed (Nair *et al.* 1988).

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[3] *The Mathrubhumi*, a malayalam daily, dated 16th February 1992 reported that Dr. J. Joseph, Ex-Joint Director, BSI spotted out a small population of *Paphiopedilum druryi* at Kalaikkad in Agastyar Hills.

Intensive explorations in several parts of Kerala have resulted in finding out rare and imperfectly known species after a lapse of several years. Based on such fresh collections, descriptions of taxa like *Rostellularia simplex* (Thunb.) Ellis (Acanthaceae), *Dioscoria wightii* Hook. f. (Dioscoriaceae), *Apama barberi* Gamble (Aristolochiaceae), *Memecylon subcordatum* Cogn. (Melastomataceae), *Piper barberi* Gamble (Piperaceae) and *Glycosmis macrocarpa* Wt. (Rutaceae) have been amended (Henry and Subramanyam 1981). Likewise, recent explorations in Quilon district alone have produced new distributional records in India for *Limnocharis flava* (L.) Buch. (Butomaceae), *Leptaspis urceolata* (Roxb.) R. Br. (Poaceae), *Mitracarpus villous* (Sw.) De. and *Spermacoce latifolia* Aubl. (Rubiaceae) (Mohanan 1981). It is also of interest that *Syzygium montanum* (Wight) Gamble earlier regarded as endemic to Nilgiris in Tamil Nadu was collected from Chanthanathode, Cannanore district (Ramachandran *et al.* 1980). Therefore intensive exploration of the forests of Kerala may change giving a new phytogeographical dimension to the flora's lineage and linkage.

The destruction of natural habitats warrants intensive and extensive study of flora of the State to determine the status of each species and its ecological requirements. Accordingly conservation strategies are to be framed to accommodate the species either in natural habitats like Wild-Life Sanctuaries, Biosphere Reserves and Biodiversity Conservation Regions or in artificial habitats like Botanic Gardens.

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FOOD AND FEEDING HABITS OF *RANA HEXADACTYLA* LESSON[3] IN KUTTANAD, KERALA[1]

SANIL GEORGE AND M.I. ANDREWS[2]

Key words: *Rana hexadactyla*, food, feeding habits

The food and feeding habits of *Rana hexadactyla* were studied at Kuttanad, Kerala. Arthropods formed the major food items of the species, with insects which were of economic importance being the primary food.

INTRODUCTION

The stomach contents of many species of anura have been examined to determine their role in an ecosystem. The food of different anuran species inhabiting temperate regions have been studied by several workers (Needham 1905, Drake 1914, Smith 1953, Tyler 1958, Brooks 1959, Berry 1965, 1970; Jensen and Klimstra 1966, Blackith and Speight 1974). However, the food and feeding habits of only a few tropical species have been investigated (Khera 1975, Issac and Rege 1975, Nigam 1979, Battish and Sandhu 1988, Battish *et al.* 1989, Sreelatha *et al.* 1990). *Rana tigerina* is known to play a significant role in controlling agricultural pests (Abdulali 1985). The food and feeding habits of *Rana hexadactyla* are not fully known (Chacko and Krishnamurthy 1951, Mondal 1970, Andrews 1979).

Kuttanad, a natural wetland in Kerala, is an ideal habitat for frogs, especially *Rana hexadactyla.* This region being the 'rice bowl' of Kerala produces one-third of the total rice cultivated in the State. The present study is an effort directed not only towards collecting data on the natural diet of the Indian green frog *Rana hexadactyla* but also towards determining the role it plays in the Kuttanad ecosystem.

MATERIAL AND METHODS

The stomach content analysis of *Rana hexadactyla* was carried out from January 1988 to December 1989. A total of 408 frogs (102 males and 306 females) were used in the present study. Adult frogs were collected from the paddy fields of Kuttanad during night and killed immediately in the laboratory. Their body weight was recorded and the stomachs removed and preserved in 10% formalin. Stomach contents were taken in a petri dish after incising the stomach longitudinally. The stomach and stomach contents were weighed, and the contents examined under a binocular dissecting microscope.

TABLE 1

STOMACH CONTENTS OF *R. hexadactyla* EXPRESSED AS PERCENTAGE OF TOTAL BODY WEIGHT WITH RESPECT TO SEX AND MONTH

Month	Sex	
	Male	Female
January	2.03	1.76
February	0.50	0.44
March	0.94	0.15
April	3.46	1.29
May	1.07	1.11
June	0.45	0.74
July	2.11	1.49
August	O.71	0.48
September	0.30	2.61
October	0.82	0.44
November	0.96	0.90
December	2.14	1.49

RESULTS

The monthly distribution of stomach contents expressed as percentage of total body weight with respect to sex and month is shown in Table 1. Males seem to consume more food than females, except in the months of May, June and September. The frog

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[1] Accepted June 1994.

[2] Department of Zoology, Mar Thoma College, Tiruvalla-689103, Kerala State.

[3] *Rana hexadactyla* is presently *Occidozyga hexadactyla* (Lesson, 1834). The classification of Indian Amphibia has undergone several changes, for details *see* S.K. Dutta (1992), *Hamadryad*, pp. 1-13.

TABLE 2

FOOD SPECTRUM OF *Rana hexadactyla* LESSON

Classified Food Item	No. of stomachs	No. of individuals	Economic Importance
Annelida			
Class: Oligochaeta			
Order: Opisthopora			
Family: MEGASCOLECIDAE			
Megascolex sp.	18	36	
Arthropoda			
Class: Insecta			
Order: Anisoptera			
Dragonfly	61	74	Carnivorous, predator
Dragonfly nymph	74	83	”
Order: Dermaptera			
Family: LABIDURIDAE			
Labidura riparia	18	22	Carnivorous
Anisolabis sp.	14	18	
Family: FORFICULIDAE			
Forficula sp.	24	33	
Family: CARCINOPHORIDAE			
Euborellia sp.	19	27	Root pest
Order: Orthoptera			
Family: GRYLLOTALPIDAE			
Gryllotalpa fosser	209	281	Paddy pest
Gryllopsis sp.	43	59	
Family: TRIDACTYLIDAE	1	2	
Family: GRYLLIDAE			
Gymnogryllus sp.	97	111	Omnivorous
Gryllus sp.	237	296	”
Family: ACRIDIDAE			
Oxya hyla hyla	132	184	Harmful to paddy
Spathosternum calignosum	4	12	”
Hieroglyphus banian	81	158	
Tryxalis sp.	6	18	
Scelimena sp.	12	19	
Order: Hemiptera			
Family: BELOSTOMATIDAE			
Spherodema rusticum	43	79	Carnivorous water bugs
S. annulatum	212	369	”
Diplonyctus sp.	1	1	
Family: JASSIDAE			
Nephotettix sp.	9	18	Harmful to crops
Family: GERRIDAE			
Gerris sp.	19	36	Water skaters
Family: HYDROMETIDAE	1	2	
Order: Lepidoptera			
Noctuid larva	18	27	Crop pest
Caterpillar	18	39	”
Hesperid larva	7	11	”
Order: Blattaria			
Family: BLATTIDAE			
Periplaneta americana	9	12	Household pest
Order: Diptera			
Family: CULICIDAE			
Anopheles sp.	47	189	Vector
Family: CHIRONOMIDAE			
Chironomus larva	11	18	Fish food
Family: MUSCIDAE			
Musca sp.	3	8	Household pest
Family: SARCOPHAGIDAE			
Parasarcophaga sp.	1	1	
Order: Hymenoptera			
Family: FORMICIDAE			
Diacamma vagans	5	8	Harmful to trees
Odontomachus sp.	1	1	”
Camponautus compressus	89	174	”
Megachilla sp.	24	69	”
Order: Coleoptera			
Family: CARABIDAE			
Anoplogenius sp.	39	74	Paddy pest
Bembidion soborium	28	61	
Chlaenius sp.	1	3	
Dioryche sp.	2	6	
Siagona sp.	4	8	
Scarites sp.	43	58	”
Pheropsopheus catorei	1	1	
Clivina sp.	1	1	
Systolocranius sp.	17	23	”
Gnathophorus sp.	1	2	
Kareya sp.	1	1	
Abacetus sp.	1	3	
Pachytrachelus sp.	1	1	

Classified Food Item	No. of stomachs	No. of individuals	Economic Importance
Family: Dysticidae			
Cybister larva	12	18	Predacious
Family: Scarabaeidae			
Anomaila dussumieri	13	29	Root pest
Anomaila chlorocarpa	16	37	Pest of Cashew
Autoserica insanabilis	3	8	"
Anserica sp.	1	1	
Mimela sp.	1	2	
Onthophagus sp.	22	43	Crop pest
Onitis sp.	1	2	
Catharsius sagax	1	1	
Chiloloba sp.	2	2	
Allisonotum sp.	2	3	
Sisyphus sp.	3	4	
Hybosorus sp.	6	8	
Holotrichia sp.	4	6	
Heteronychus sp.	5	18	Paddy pest
Popilla sp.	12	16	
Family: Hydrophilidae			
Sternolophus brachyacanthus	6	21	Pest stored food grain
Hydrophilid sp.	2	8	Larva predacious
Family: Elateridae			
Melanotus hirticornis	2	2	Pest of stored food grain
Heteroderis sp.	1	1	
Lema sp.	1	1	
Attica sp.	1	1	
Family: Curculionidae			
Odioporus sp.	2	2	
Plococerus sp.	1	1	
Sipalus sp.	2	2	Crop pest
Xanthoprochilus sp.	4	4	
Family: Tenebrionidae			
Gonocephalum sp.	18	36	Paddy pest
Scleron sp.	1	1	
Mesomorphus sp.	1	1	
Hematismus sp.	1	1	
Family: Coccinellidae			
Coelophora sp.	8	18	
Class: Crustacea			
Order: Decapoda			
Palaemon sp.	17	36	Useful
Paratelphusa bouvieri	43	67	Serious paddy pest
P. hydrodromus	18	24	"
Class: Arachnida			
Order: Lycosidae			
Paradosa songosa	83	147	Biological control agent
Paradosa bursantiensis	79	116	"
Paradosa sp.	22	48	
Hippassa sp.	20	43	
Lycosa iranii	3	12	"
Lycosa sumatrana	6	18	"
Lycosa bistriata	6	19	"
Family: Tetrognathidae			
Tetrognatha sp.	12	21	"
Tetrognatha andamanensis	94	167	"
Tetrognatha mandibulata	7	18	"
Family: Araneidae			
Neoscona legubris	31	69	
Family: Hetropodidae			
Heteropoda sp.	10	21	
Class: Myriapoda			
Family: Scolopendridae			
Otostigmus sp.	4	7	
Millipede	11	16	
Mollusca			
Class: Gastropoda			
Order: Basommatophora			
Family: Planorbidae			
Indoplanorbis exustus	16	22	
Family: Pilidae			
Pila sp.	1	1	Useful
Order: Systellommatophora			
Family: Veronicellidae			
Laevicaulis sp.	1	1	
Pisces			
Family: Cyprinidontiformes			
Haplochilus punchax	11	18	Larvivorous, biological control agent
Family: Cypriniformes			
Rasbora daniconius	3	6	Edible fish
Family: Perciformes			
Etroplus sp.	1	1	"
Amphibia			
Order: Anura			
Family: Ranidae			
Rana cyanophlyctis	2	3	Useful
Rana hexadactyla	1	1	Edible frog

Classified Food Item	No. of stomachs	No. of individuals	Economic Importance
Reptilia			
Order: Opidia			
Typhlops sp.	1	6	Predator
Order: Squamata			
Calotes sp.	3	4	Predator
Stones, leaves and debris	—	Many	

feeds on a variety of animals belonging to 20 orders. The most predominant insect orders were Orthoptera, Coleoptera and Hemiptera (Table 2). Other than the insects, spiders and crabs were the main food items. Vegetable matter, stones and other debris were also found in most of the stomachs examined during the present study.

The economic importance of some of the food items is represented in Table 2. It is evident that *R. hexadactyla* is a natural predator of many of the agricultural pests, especially paddy pests found in Kuttanad. Many of the serious paddy pests like *Gryllotalpa fosser. Oxya hyla hyla, Hieroglyphus banian, Anoplogenius* sp., *Gonocephalum* sp., *Paratelphusa bouvieri* and *P. hydrodromus* and other crop pests such as *Nephotettix* sp., *Euborellia* sp., *Nectuid* larva, *Bombidion soborium, Scarites* sp. and *Sipalus* sp. were present in the stomachs. *Anopheles* sp. is also an important food item of this frog. Pests of stored food grains like *Sternolophus brachyacanthus. Melanotus hiriticornis* and *Anomaila chlorocarpa,* an important pest of cashew, were also found in the food spectrum. Other species found in the stomachs of *R. hexadactyla* included fish food organisms, prawns, fishes and some frogs. However, their numbers were very low.

R. hexadactyla is usually found in water and its aquatic habit is reflected by the large proportion of aquatic insects eaten by it. Movement of the prey attracts the attention of this frog, whose first reaction is to jump upon and swallow its prey, all in a single movement. The frog may detect the prey from some distance and then approach it in a series of bounds, the last leap being made onto its prey. The forelegs are used to push into the mouth any item which the frog may not be able to swallow completely.

Discussion

The food spectrum obtained in the present investigation indicates that insects form the main diet. From the observations recorded in the present study, it is noticed that insects, spiders and crabs are the major food items of *R. hexadactyla.* Arthropods thus form the bulk of the diet. Amongst the arthropods, insects appear to be the most favoured food, some of the insects being of economic importance. Issac and Rege (1975) and Abdulali (1985) have reported that *R. tigerina* played a significant role in controlling agricultural and other pests in the field. Crabs were found in large numbers in the diet of *R. hexadactyla.* They are often seen in the paddy fields and cause damage to the bunds in the fields by boring holes in them. Crabs are considered as one of the major pests of paddy (Kadam and Patel 1960) and are known at certain stages of their life to feed on rice seedlings both before and after transplanting. The frog is thus useful in controlling the crab population harmful to agriculture. Some gastropods were also recorded from the stomachs of a few frogs. Vertebrate groups such as fishes, amphibians and and reptiles were also recorded but there was no reason to believe that they formed regular items of the diet (see Andrews 1976).

The presence of stones, leaves and debris among the gut contents of *R. hexadactyla* may be the result of accidental ingestion. Vegetable matter occurred in many guts, but the quantity was small; it might have been inadvertently ingested with the food. The intake of pebbles and plant matter may be important in providing roughage as well as increasing grinding capacity for the total mass ingested. The presence of stones and vegetable matter in the guts of anurans has also been reported by earlier workers (Battish *et al.* 1989, Sreelatha *et al.* 1990, George *et al.* 1992).

Mondal (1970) observed that the "northern race" of *R. hexadactyla* was a herbivore while the "southern race" preferred animal food. The present study indicates that *R. hexadactyla* in Kuttanad is carnivorous, as noted by Andrews (1979).

The present study reaffirms that frogs are useful as control agents for various insect pests especially those which are considered as serious crop pests. Though frogs are opportunistic feeders, their feeding on many phytophagous insect pests does support their usefulness as biocontrol agents. This fact has been stressed by several earlier workers (Abdulali 1985, Battish *et al.* 1989, Sreelatha *et al.* 1990, Sally *et al.* 1992).

The decline in the population of frogs in Kuttanad due to commercial capture for their legs and the effect of pesticide residues in the area may be detrimental to crops, especially paddy.

ACKNOWLEDGEMENTS

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THE POPULATION DENSITY AND STRUCTURE OF ASIAN ELEPHANTS IN PARAMBIKULAM WILDLIFE SANCTUARY, KERALA, INDIA[1]

P.S. Easa[2] and M. Balakrishnan[3]

(*With three text-figures*)

Key words: Asian Elephant, *Elephas maximus,* Parambikulam Wildlife Sanctuary, population, biomass, density, group composition, solitary elephant

The population of Asian elephants in Parambikulam Wildlife Sanctuary, Kerala, India was studied during 1981-1983. The sanctuary with an area of about 270 sq. km has both natural forests and plantations. A total count indicated about 114 elephants with an ecological density of about 0.5 animal/sq. km. The biomass was about 905 kg/sq. km. The herd size frequency showed a polymodal distribution. The herd size of eleven was more frequent. The basic family unit in the population was around five. There was no significant seasonal or monthly differences in herd size. Forty three percent of the herds were without bulls. About 66% of the adult males observed were solitary. The sex ratio of 1:6.8 (male:female) indicates a slight increase in male mortality. The proportion of juveniles and calves (21%) indicates a high percentage of breeding females in the population.

INTRODUCTION

The populations of Asian elephant *(Elephas maximus)* in India have been affected adversely by a growing human population and the resultant destruction of natural habitat for settlement and cultivation. Poaching for tusks have also contributed to their depletion. The status of Asian elephants in India has been reviewed by Daniel (1980). However, apart from the studies conducted by Sukumar (1985), no detailed data have been published on Asian elephants in India.

The total number of an animal such as the elephant in an area is important because of its large contribution to the biomass with its limited numbers. Herd size and composition provide information on social organisation of the species, and are often related to environmental conditions (Leuthold and Leuthold 1975). Nair *et al.* (1985), Nair and Balasubramanyan (1985) and Easa and Balakrishnan (1990) describe number, herd composition and age structure of elephant populations in different sanctuaries of Kerala. The present paper deals with the number, herd composition and size and population structure of the Asian elephant in Parambikulam Wildlife Sanctuary, Kerala, during 1981-1983. This paper forms part of the detailed ecological study of the species in the area.

STUDY AREA

The Parambikulam Wildlife Sanctuary (76° 35' and 76° 50' E and 10° 20' and 10° 26' N) is 270 sq. km in area and is situated at an elevation of 600 m above sea level. It is contiguous on all sides with forests and includes three water reservoirs of about 28 sq. km area. The habitat includes tropical wet evergreen forests, moist deciduous forests, grasslands, swamps, and plantations of teak and eucalyptus.

The temperature in Parambikulam ranges from 13°C to 32°C. The average annual precipitation is 2590 mm. The area gets both the south-west and north-east monsoons. However, south west monsoon is more active in the region. The rainfall data of the area indicate two seasons — dry (January to May) and wet (June to December). A detailed description of the study area is given by Easa and Balakrishnan (1990).

METHODS

The study area was covered on foot every month during 1981-83. Herd size and composition

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[1] Accepted December 1994.

[2] Division of Wildlife Biology, Kerala Forest Research Institute, Peechi, Kerala-680 653, India.

[3] Department of Zoology, University of Kerala, Kariavattom, Trivandrum, Kerala, India-695 581.

and population structure of herds encountered were noted by direct observation. A herd was defined by the criteria of Kurt (1974). Elephants were classified into different age groups as suggested by Eisenberg and Lockhart (1972). The height of individuals were assessed by the photogrammetric method to allow age determination (Laws 1966). A total count of elephants was made by Kerala State Forest Department in May, 1983. The study area was divided into fourteen blocks of almost equal size and each block was covered by a team of three investigators. All blocks were covered equally in one day on foot noting the number, sex and age group of elephants encountered. Results of this census was used only for total number and density of elephants within the sanctuary.

ANALYSES

The biomass of elephants within the sanctuary was calculated using an average weight of 1810 kg/animal (Eisenberg and Lokhart 1972). A solitary elephant was considered as a herd for calculating herd size frequency. The monthly and seasonal variations in herd size were estimated by pooling the herd size data over months. Variances in herd size in each season was compared by F test. A student t-test was used for testing the difference between mean herd size for the two seasons, and one way ANOVA for the monthly data. The proportion of solitary elephants out of the total number of herds computed for different months and seasons were compared using X^2 test. A similar test was done for comparing the proportion of the loners in two seasons. Herd composition estimates were developed, excluding loners, based on all sightings (Cochran 1977) and monthly data. These were compared through a X^2 test and found to be non-significant (X^2 (5,0.05)=0.03 ns). Hence the population structure was derived based on all sightings. The standard error for population structure was calculated from multiple values obtained from blocks.

RESULTS

The count conducted in May, 1983 showed a total of 114 elephants in the Sanctuary. Of these, 55 (48%) were adult females, 35(31%) were adult males and 24(21%) juveniles and calves. The ecological density of the species in the area was about 0.5 animal/ sq. km. The biomass was about 905 kg/sq. km.

Herd Size Frequency: The herd size frequency shows a polymodal distribution with peaks occurring at 1, 5, 9 and 11 (Fig. 1). A strong tendency for herd sizes between 3 and 7 is evident, suggesting that the basic unit in the population could be around five.

There were no significant seasonal ($t_{89,0.05}$ = 0.97 ns) or monthly ($F_{(11,80)0.05}$ = 1.23 ns) differences in herd size, despite the large variation in monthly means (Fig. 2).

Solitary Elephants: Sixty six percent of the 35 adult males observed were solitary (Fig. 2). Only one lone adult female was seen. A single bull group with two tuskers was observed. There was no significant seasonal ($X^2_{(1,0.05)}$ = 0.81 ns) or monthly ($X^2_{11,0.005)}$ = 18.48 ns) variation in the proportion of solitary elephants in the population.

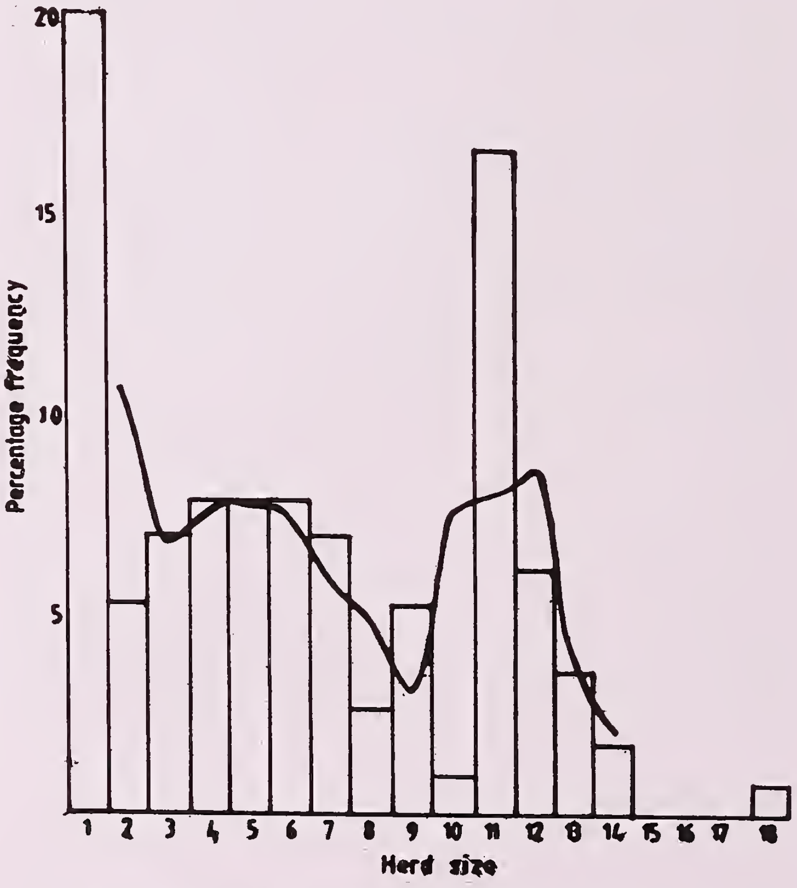

Fig. 1. Percentage frequency distribution of group size of Asian elephants.

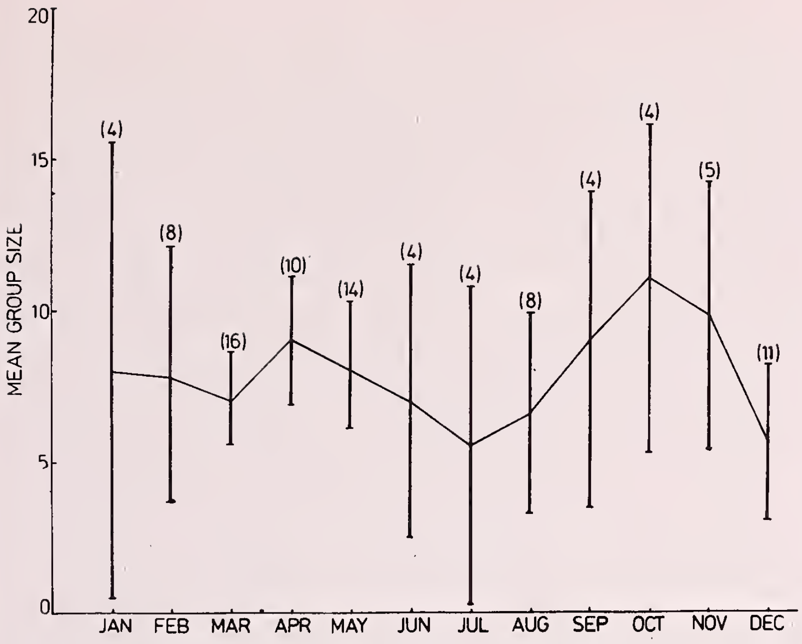

Fig. 2. Monthly mean group size of elephants with error bar. The figures in parentheses denotes sample size.

Population Structure: The percentage frequency distribution of age and sex classes in the population is shown in Fig. 3. The sex ratios in the population with their standard errors are summarised in Table 1.

Table 1

SEX RATIO IN THE ELEPHANT POPULATION IN PARAMBIKULAM WILDLIFE SANCTUARY, KERALA

Age Classes and Sex	Ratio	SE
Adult female/Adult male	6.825	1.27392
Sub-adult female/Sub-adult male	1.913	0.47744
Adult female/Calf	3.102	0.22153
Adult female/Juvenile	2.007	0.12908
Females/Males	5.032	0.75620
Adult male/Sub-adult male	1.739	0.44672
Adult female/Sub-adult female	6.205	1.19687

Discussion

The results of 1983 census show that the number of elephants in Parambikulam have increased by about 27% since 1981 (Balakrishnan and Easa 1986) with a 45% increase in females and 9% in males. However, the increase could be due to the seasonal movements of elephants from adjoining areas, especially Indira Gandhi Wildlife Sanctuary, during the dry season due to the presence of three reservoirs in Parambikulam Wildlife Sanctuary.

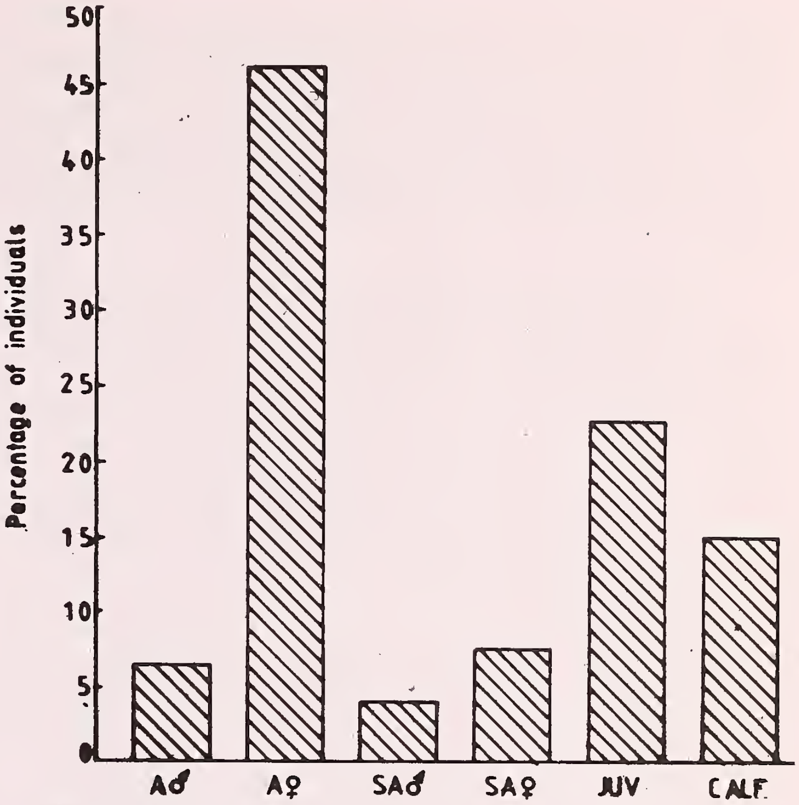

Fig. 3. Percentage frequency distribution of age and sex classes of elephant in the population.

Easa (1989) has observed that the summer home ranges of elephant herds appear to be around the reservoirs within Parambikulam. At the onset of rains, the herds extend their ranges to the Indira Gandhi Wildlife Sanctuary. Still, a slight increase in the population cannot be ruled out as evident from the percentage of juveniles and calves (21%) in the population.

The density of elephant in Parambikulam is higher than for other Asian elephant habitats (Eisenberg and Lockhart 1972, Olivier 1978, Ishwaran 1984 and Santiapillai *et al.* 1984). However, this represents a seasonal peak. Eisenberg and Seidensticker (1976) have opined that in suitable south east Asian habitats, density of elephants could range from 0.1 to 1.0/sq. km. Considering the contiguity of elephant populated habitat in areas adjacent to Parambikulam, the density could be much lower than obtained.

Nair *et al.* (1985), Sukumar (1985) and Olivier (1978) obtained polymodal distributions of herd size frequency. Olivier (1978) concluded that the basic family unit was six individuals. The smaller herd size more frequent in our population might be due to the comparatively forested habitat in the area (Peek *et al.* 1974, Leuthold 1976). The herd size of eleven frequent in our population indicates both generation overlap and extended family units (Eisenberg and Lockhart 1972).

The large differences between monthly means of herd size appears to disagree with the findings of Leuthold (1976) and Rodgers (1976) and may be due to the environmental factors, such as heavy rainfall in June-July, changing the stage of vegetation favouring aggregations of smaller units (Douglas-Hamilton 1972).

Male elephants seen on their own at one time were later seen with a herd for a short period of time. Many herds (43%) observed were without bulls. McKay (1973) and Sukumar (1985) reported 60% and 23% of herds respectively without bulls. McKay (1973) reported that the association of males with the herds lasted only for a few days. The proportion of solitary elephants does not vary in relation to season or month suggesting a constant proportion of adult bulls in association with the herds throughout the year. Considering this and the shorter period of time spent by any male with the herd, it could be seen that the possibility of outbreeding is enhanced.

Assuming an equal sex ratio at birth, it appears that there was a higher mortality of males creating an adult sex ratio biased towards females. However, Sukumar (1985) considering 17.5 years as age of first conception and 4.7 years as mean calving interval, has shown by simulation that a medium male — medium female mortality could stabilize the ratio at 1:5.7. The adult sex ratio of 1:6.8 in the present population indicates a slight increase in the male mortality. The lesser disparity in the percentage of sub-adult females and sub-adult males indicates a decrease in recruitment to the population during a particular period of time and could produce delayed effects on population growth. However, the percentage of juveniles and calves is an indication of nullification of such an effect in the immediate future. The proportion of juveniles and calves in relation to the adult females is an indicator of a high percentage of females breeding in the population. However, further studies, on the age of first conception and the mean calving interval, would be required to assess the trend in the population.

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PHYLOGENY AND ZOOGEOGRAPHY OF THE GHARIAL, *GAVIALIS GANGETICUS* (GMELIN) (REPTILIA, CROCODILIA)[1]

A.K. Srivastava[2] and H.R. Bustard[3]

(With a text-figure)

Key words: *Gavialis, Tomistoma,* phylogeny, zoogeography, morphology, lineage

The accepted theory is that the family Hylaeochampsidae of the order Eusuchia branched into the family Gavialidae on one side and into the families Stomatosuchidae, Nettosuchidae and Crocodylidae, on the other. The zoogeography of *Gavialis,* based on systematics, continental drift, anatomy and physiology, suggests that *Gavialis* has affinities with both *Tomistoma* and *Mesosuchia.* Like *Tomistoma,* it is an inhabitant of fresh water and both probably had ancestors adapted to salt water. The buccal morphology of *Gavialis* resembles species of marine origin.

The *Gavialis* drifted from India to other Asian countries during the Miocene and then it remained confined to India in the pleistocene respectively. Fossil records also refer to its presence in Africa and South America. The current existing populations of *G. gangeticus* is restricted to the Indian subcontinent.

INTRODUCTION

Many theories of evolution, phylogeny and zoogeography of crocodilians have been propounded. The 'phylogeny and ancestral relationship of the crocodilian genus, *Gavialis* is still debatable (see Mook 1934, Lull 1944, Sill 1968, Densmore 1983) although the phylogeny of the Crocodilia in reference to taxonomy has been dealt in detail by Sill (1968).

Densmore and Dessauer (1982) and Densmore (1983) employed biomedical and immunological techniques while Pandey (1991) explained the role of endocrinology in the phyletic picture of reptiles. Subsequently, Blofield *et al.* (1992) used haematological implications to understand the phylogenetic relationship.

Sill (1968) reviewed the zoogeography and continental dispersal of eusuchian crocodilians. However, little information is available on the phylogeny, zoogeography, and dispersal of *Gavialis* (Hecht and Malone 1972, Buffetaut 1978, 1982; Buffetaut and Thomas 1981). Taplin and Grigg (1989) explained that eusuchian zoogeography is based on new information pertaining to their systematic relationship and physiological capacity for marine dispersal and on fossil records. The available data is reviewed here.

A. PHYLOGENY

The phylogeny of eusuchian crocodilians is based on the fossil history and biology of the existing crocodilian species.

Taplin and Grigg (1989) discussed the phylogeny of *Gavialis* and concluded that

* Anatomical and physiological adaptations to marine existence have played an important role in eusuchian history.

* *Gavialis* and *Tomistoma*, now restricted to freshwater, may have been derived from ancenstors adapted to salt water.

— The buccal morphology of *Gavialis* suggests that it also has a marine ancestry.

— The systematic affinities of *Gavialis* are uncertain, lying perhaps with *Tomistoma* and on other interpretations with Mesosuchia.

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[1] Accepted December 1994

[2] National Laboratory, Animal Centre,
Central Drug Research Institute, Chattar Manzil,
Lucknow-226 001, India.

[3] Airlie Brae, Alyth, Perthshire, PH11 8AX, Scotland, U.K.

Densmore (1983) and Densmore and Owen (1989) discussed the eusuchian zoogeography on the basis of biomedical and immunological studies of existing crocodilian species, highlighting:

(i) The living eusuchians form a monophyletic group with three major lineages: crocodiles, alligators and gavialids.

(ii) *Gavialis* and *Tomistoma* are members of a monophyletic group, more closely related to the crocodile lineage than to the alligators.

(iii) *Gavialis* and *Tomistoma* are members of a common lineage. Buffetaut and Thomas (1981) and Buffetaut *et al.* (1984) proposed that *Gavialis* is derived from tomistomines which originated in the old world (probably Africa) in the early Tertiary and migrated to South America and India.

The physiological capabilities of the lingual glands in crocodilians have been taken into account to postulate the evolution and zoogeography in Eusuchia,

Taplin *et al.* (1985) and Taplin and Grigg (1989) noted that lingual gland pores are evident on the tongues of both *Tomistoma* and *Gavialis* and that the glands in *Gavialis* are minute in size and have a very low secretory capacity comparable to the alligatorids than examined. They also recorded that the general appearance of the tongue and buccal cavity of both *Gavialis* and *Tomistoma* is distinctively crocodyline rather than alligatorid. The explanation of the similarities in buccal structure is seen in *Tomistoma* and *Gavialis*, the salt glands and their associated buccal modifications have developed during adaptation to a marine existence. They considered the possibilities of adopting Buffetaut's view that gavialids are derived from tomistomines or considering Tarsitano's (1985) view that gavialids originated independently from a thalatosuchian stock and concluded that buccal anatomy of *Gavialis* and *Tomistoma* are crocodyline and both have a common lineage, and buccal morphology of *Gavialis* shows its ancestery from marine stock. However, it is still controversial as to whether the gavialids are derived from tomistomines or Mesosuchia, or originated independently from Thalatosuchians (Fig. 1).

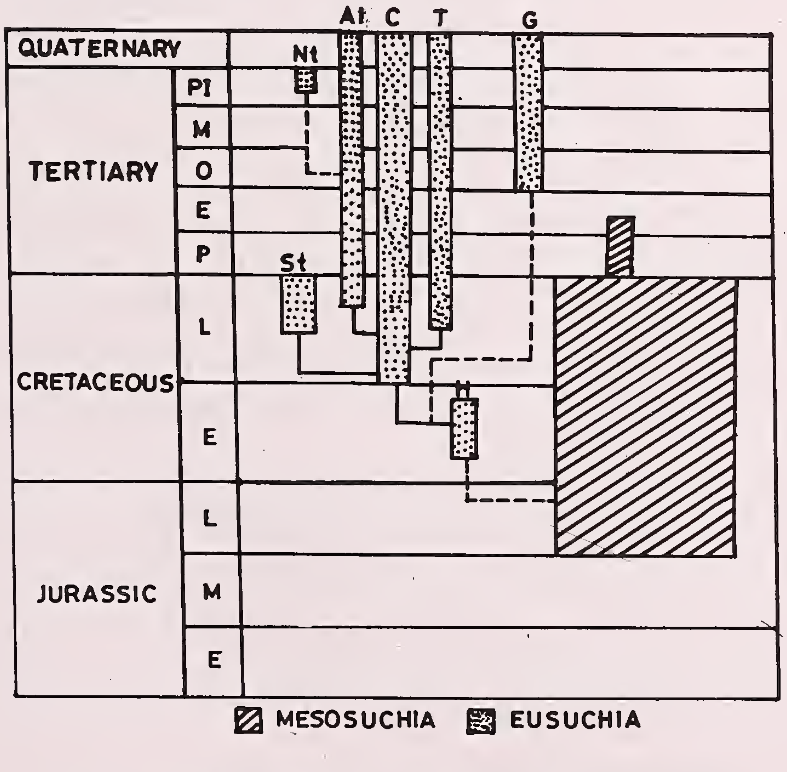

Fig. 1. Phylogeny of family Gavilidae. Al-Alligatorinae; C-Crocodilinae; G-Gavialidae; H-Hylaeochampsidae; Nt-Nettosuchidae; St-Stomatosuchidae; T-Tomistominae.

B. Classification of *Gavialis gangeticus*:

The family Gavialidae belongs to the suborder Eusuchia of the Order Crocodilia. The animals of the Order Crocodilia came into existence during the middle Triassic period. The order includes five suborders, Sill (1968)

1. Suborder : Archeosuchia Sill, 1967. Extinct
2. Suborder : Protosuchia Mook, 1934. Extinct
3. Suborder : Mesosuchia Huxley, 1875. Extinct
4. Suborder : Sebecosuchia Simpson, 1937. Extinct
5. Suborder : Eusuchia Huxley, 1875. Living.

The only living Suborder Eusuchia of the Order Crocodilia has five families: 1. Hylaeochampsidae; 2. Stomatosuchidae; 3. Gaviallidae; 4. Nettosuchidae; 5. Crocodilidae.

The family Hylaeochampsidae is the most primitive and has given rise on one side to the families Stomatosuchidae, Nettosuchidae and Crocodylidae and on the other to the family Gavialidae (Fig. 1).

The family Gavialidae is represented by one surviving genus *Gavialis* containing a single species *Gavialis gangeticus* Gmelin (1789), commonly know as the gharial.

The distinguishing characters of *Gavialis* listed below suggest its relatively long isolation from other crocodilies.

i. Depression of postorbital bar; ii. Jaw articulation of different angle and shape; iii. Elongation of snout by extension of only the maxillaries instead of both maxillaries and nasals, as in other longirostrine crocodiles.

The long slender snout is an adapation to a diet consisting almost exclusively of fish. *Gavialis* possesses an elongated snout, characteristic skull profile and close spacing of teeth. The genus *Gavialis* has been confined to the Indian peninsula from the early Miocene to the present time (Lull 1944).

C. ZOOGEOGRAPHY:

The Zoogeography of *Gavialis* was initially based on the fossil history and evolution of the eusuchians. This has been continuously modified taking into account the biology of the species. The debate has now centered on the anatomy and physiology of *Gavialis* relative to its zoogeography and dispersal.

Buffetaut (1978, 1982, 1985 a, b) proposed that the appearance of gavialids in the Oligocene of South America called for a trans-Atlantic migration across the developing South Atlantic Ocean in the upper Eocene or early Oligocene. Buffetaut and Thomas (1981) and Buffetaut *et al.* (1984) proposed that *Gavialis* is essentially a highly derived tomistomine which originated in the Old World (probably Africa) in the early Tertiary and migrated to South America and India. Buffetaut interpretations are rejected by Tarsitano *et al.* (1989) whose analysis of cranial morphology and hind limb, and cranial musculature points to a separate origin of the gavialids, perhaps from the Mesozoic thalattosuchians. Taplin and Grigg (1989) discussed a detailed scenario for the zoogeography of eusuchians using a physiological perspective and the interpretations of many workers and concluded that the early Tertiary disjunction of gavialid distribution was between Africa and South America. They further discussed a tomistomines and gavialid lineage. The salient features dealing with the zoogeography of gavialids are:

(1) Longirostrine crocodilians regarded as being from the tomistomine lineage, are from the upper cretaceous and early tertiary of Europe and North America.

(2) The proposition that gavialids belong to the tomistomines lineage, as it is presently known, requires either an Oligocene crossing of the South Atlantic (a barrier some 1000 km wide), or convergent evolution of similar skull form in New and Old World lines which separated at a much earlier date (Buffetaut 1980, 1985 a, b, c). Taplin and Grigg (1989) added that gavialids are derived tomistomines as they are presently recognized and include marine and littoral forms.

(3) The gavialids are considered by Buffetaut (1985 b) to have had at least three branches, the Indian and Asian *Gavialis* species, a South American branch and the widespread *Gavialosuchus* of North American lines (known only from fossils of fresh water deposit). The occurrence of *Gavialis* in the Pleistocene of Java is inconsistent with dispersal of a derived freshwater stock through the Asian archipelago. *Gavialosuchus* enjoys a much more widespread distribution than other gavialids and is characteristic of the littoral and marine strata of the Atlantic seaboard of Europe, Africa and North America.

(4) The fossil record is inconsistent with the view that the sole surviving modern freshwater gavialid and *Tomistoma* are derived from marine adapted ancestors and retain some characteristic physiological and anatomical specializations.

(5) Gavialids might have close affinities with the characteristically marine thalattosuchians than are Mesosuchia, and are considered to be a

secondarily derived fresh water crocodilian.

On the basis of the above discussions and fossil history one view is that the gavialids are tomistomines that originated in the Old World (Africa) and migrated to South America and India. A second view holds that gavialids had three branches: (i) The Indian and Asian gavialids, (ii) The South American branch and (iii) The *Gavialosuchus* of North America. This subject deserves more study for a final conclusion.

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NEW DESCRIPTIONS

REVISION OF GENUS *INDOTAXONUS* MALAISE FROM INDIA (HYMENOPTERA, SYMPHYTA, TENTHREDINIDAE: ALLANTINAE)[1]

Malkiat S. Saini and V. Vasu[2]

(With twenty three text-figures)

Genus *Indotaxonus* Malaise from India is revised. Five species are described and illustrated in a uniform pattern. Described as new are *I. bicoloris, I. canaliculus* and *I. tajinderi*, while *I. unicolor* Malaise is the first report from India. Treatment of each taxon includes synonymy (if any), detailed description, collection data, population variation (if any), and distribution. A key is provided for all the species described.

Introduction

Genus *Indotaxonus* was described by Malaise in 1957 with *Taxonus tricoloricornis* Konow, as its type species. While shifting *Taxonus tricoloricornis* Konow, 1898 to *Indotaxonus,* Malaise also synonymised *Allomorpha varicornis* Cameron, 1899.

In this article we describe five species which include one that has already been reported, one as a first report and three as new to science. The holotypes of the new species are presently in our collections and will be deposited in the Indian Agricultural Research Institute (IARI), Pusa National Collections, New Delhi, India, after this work is published.

Abbreviations used are: LID = lower interocular distance, IDMO = inter-ocular distance at the level of median ocellus, EL = eye length, OOL = oculo-ocellar line, OCL = ocello-occipital line, POL = postocellar line, IATS = inner apical tibial spur, OATS = outer apical tibial spur, MB = metabasitarsus, ICD = inter-cenchri distance, ITD = inter-tegular distance.

Genus *Indotaxonus* Malaise, 1957

Indotaxonus Malaise, 1957. Entomol. Tidskr. Arg. 78: 19-22.

Type species: *Taxonus tricoloricornis* Konow, 1898.

Diagnosis: Adult: Body fulvous with few black and pale yellow markings. Wings yellowish hyaline, hardly infumated towards apex, costa and stigma fulvous, venation blackish.

Antenna long and slender, longer than head and thorax combined, scape and pedicel longer than broad, segments 3 and 4 subequal in length, 4 or 5 apical joints strongly compressed; clypeus semicircularly incised with blunt and depressed lateral teeth; labrum flat, pentagonal; mandibles asymmetric, right one simple, left with a broad basal tooth; inner margins of eyes subparallel; malar space 1x diameter of median ocellus; postocellar area longer than broad; lateral furrow deep and sharp; mesoscutellum pyramidally elevated; metabasitarsus longer than following tarsal joints combined, tarsal claw with a large subapical tooth in addition to an apical tooth and minute basal lobe. In front wings, anal cell with oblique cross vein; hind wings with two closed middle cell in female, none in male; anellan cell not petiolate.

Distribution: China, Burma; India.

Remarks: This genus is characterised by the males with the hind wings without closed middle cell and females with 2 closed middle cells. The anellan cell is not petiolate.

Key to the species of Genus *Indotaxonus* Malaise from India

1. Antenna bicoloured, apical segments black 2
— Antenna tricoloured, apical segments not black 3
2. Wings entirely hyaline; lateral flecks on terga 3-6 present; head impunctate; mesoscutellum without a row of large, shallow punctures on its posterior border .. .. *I. bicoloris* sp.nov.

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[1] Accepted May 1994.

[2] Department of Zoology, Punjabi University, Patiala-147 002, India.

— Apical halves of wings infuscated; lateral flecks on terga 3-6 missing; head with dense, minute, irregular punctures; meso — scutellum with a row of large, shallow punctures on its posterior border .... *I. unicolor* Malaise, 1957

3. Median fovea deep, ditch -like and clearly though narrowly reaching median ocellus .... *I. canaliculus* sp. nov.

— Median fovea deep pit or ditch - like in its anterior half and posteriorly only broadly, shallowly reaching median ocellus 4

4. Mesonotal middle lobe entirely fuscoferruginous (no blackish spot); postocellar area longer than broad, ratio 4:3; antennal segments 3 and 4 equal; OOL:POL:OCL = 3:2:4; metabasitarsus equal to following joints combined .... *I. tajinderi* sp. nov.

— Mesonotal middle lobe with some black markings atleast at its anterior margin; postocellar area longer than broad, ratio 3:2; antennal segment 3 shorter than 4, ratio 6:7; OOL:POL:OCL = 3:2:3; metabasitarsus longer than following joints combined, ratio 8:7 .... *I. tricoloricornis* (Konow, 1898)

Indotaxonus bicoloris sp. nov.

(Figs. 2,5,11,15,19)

FEMALE: **Colour**: Body fuscoferruginous, black areas are: antennal segments 6-9; mandible tip; a spot between ocelli extending up to supra-antennal pit along antennal furrows; a streak along lateral furrows; a medial stripe on pronotum; extreme anterior margin of mesonotal middle lobe; lateral aspects of mesonotal lateral lobe; anterior aspects of mesepisternum and mesosternum; a median stripe on mesepimeron; metapleuron entirely; lateral flecks on terga 3-6 (more broad and large on 3 and 4). Legs fuscoferruginous. Wings hyaline; costa and basal 1/2 of stigma fulvous; rest of venation including subcosta black.

Structure: Average length 9 mm. Antenna long, 2.7X of head width; scape twice as long as its apical width; pedicel as long as its apical width; segments 3 and 4 almost equal; segments 6-9 strongly compressed; clypeus (Fig. 2) circularly incised up to 2/3 of its medial length; labrum (Fig. 2) broader than long, ratio 3:2, with pointed anterior end; malar space of the diameter of median ocellus; head with postgenal carina; hind orbits carinated; LID:IDMO:EL = 7:8:5; frontal area below the level of eyes; supra-antennal tubercles and frontal ridges insignificant; median fovea in the form of a broad pit in its anterior half and posteriorly only shallowly reaching median ocellus; post-, inter-and circumocellar furrows sharp and distinct; lateral furrows deep, distinct, parallel and ending just before the hypothetical hind margin of head; postocellar area longer than broad, ratio 3:2, with a faint medial longitudinal carina in its anterior half; head narrowing behind eyes; OOL:POL:OCL = 7:4:8; mesoscutellum pyramidally raised; appendage not carinate; ICD:ITD = 1:3; tarsal claw (Fig. 8) with a subapical tooth stronger but shorter than apical one and a distinct basal lobe; meta-basitarsus almost equal to following joints combined; metatibial spurs subequal in length; IATS:MB:OATS = 1.25:4:0.75. Lancet (Fig. 19) with 24 serrulae. Hypopygium as in Fig. 5.

Sculpture and pubescence: Head impunctate, shining; thorax impunctate except mesepisternum which bears dense, deep, distinct, confluent punctures on its convexity, surface shining with general oily lustre; abdomen impunctate subshining. Body covered with golden pubescence.

MALE: Average length 8 mm. Similar to female except the flecks on terga may be missing. *Male genitalia*: Penis valve (Fig. 11), gonoforceps (Fig. 15).

Holotype: Female, Nagaland: Pfutsero, 2100 m, 20 May, 1993.

Paratypes: Nagaland: 1 male, Wokha — 1300 m, 15 September, 1992; 2 males, Vizho-Razho-1600 m, 11 May, 1993; 1 female, 3 males, Zunheboto-1874 m, 14 May, 1993; 3 females, 8 males, Pfutsero-2100 m, 20 May, 1993.

Population variation: Entire flagellum may be black.

Distribution: INDIA: Nagaland.

Diagnostic characters: Though *I. bicoloris* is allied to *I. unicolor* Malaise, it remains distinct from all other species dealt herewith on the basis of some significant characters such as: presence of lateral flecks on terga 3-6; characteristic shape of median fovea; entirely hyaline wings; absence of a row of large punctures on posteior border of mesoscutellum and impunctated head.

Etymology: The species name pertains to its bicoloured antenna.

Indotaxonus unicolor Malaise, 1957

(Figs. 3, 6, 9, 20)

Indotaxonus unicolor Malaise, 1957. Entomol. Tidskr. Arg. 78, H-I. p.22.

FEMALE: **Colour:** Body fuscoferruginous, dark brown to black areas are: 4 apical antennal segments; mandible tip; stripe along antennal furrow; narrow stripe surrounding each ocellus; stripe along lateral furrow; Y-shaped lateral spot on pronotum; stripe along dorsal and posterior margin of metapleuron; tip of sawsheath. Wings hyaline with infumated apices, more pronounced in forewing, costa a nd basal half of stigma fulvous, distal half of stigma and venation dark brown.

Structure: Average length 11 mm. Antenna 3x head width, scape and pedicel twice as long as their apical widths; segment 3 and 4 equal in length, flagellum compressed; clypeus (Fig. 3) circularly incised up to 1/2 of its medial length with subtriangular lateral teeth and wavy margin; labrum (Fig. 3) broader than long in ratio 3:2, flat with roundly pointed anterior margin; LID:IDMO:EL = 6:7:5; malar space half the diameter of median ocellus; frontal area almost at the level of eyes; median fovea in form of medial depression; postocellar area elevated, longer than broad in ratio 3:2, with faint indication of longitudinal carina on anterior 1/3, post-, inter-, and circumocellar furrows sharp; lateral furrows parallel, deep and ending just before the hypothetical hind margin of head; OOL:POL:OCL = 3:2:4; head narrowing behind eyes; mesoscutellum convex; appendage not carinate; ICD:ITD = 1.0:3.5; tarsal claw (Fig. 9) with a subapical tooth stronger but shorter than apical one and a distinct basal lobe; metabasitarsus longer than following joints combined, ratio 6:5; IATS:MB:OATS = 1.0:4.0:1.0. Lancet (Fig. 20) having 23 serrulae. Hypopygium as in Fig. 6.

Sculpture and pubescence: Head minutely and sparsely punctured; mesonotum and mesoscutellum densely and distinctly punctured; appendage polished; mesopleuron minutely punctured with large scattered punctures along convexity; abdomen polished. Body covered with golden pubescence.

MALE: Not found.

Population variation: Not observed.

Holotype Depository: Female, NR, Stockholm.

Paratype Depository: 2 Males, NR, Stockholm.

Specimens examined: UTTAR PRADESH: 2 females, Barkot-2000 m, 8 June, 1983. MEGHALAYA: 1 female, Smit-1500 m, 15 September, 1985; 1 female, Mawphlang -1500 m, 17 September, 1985.

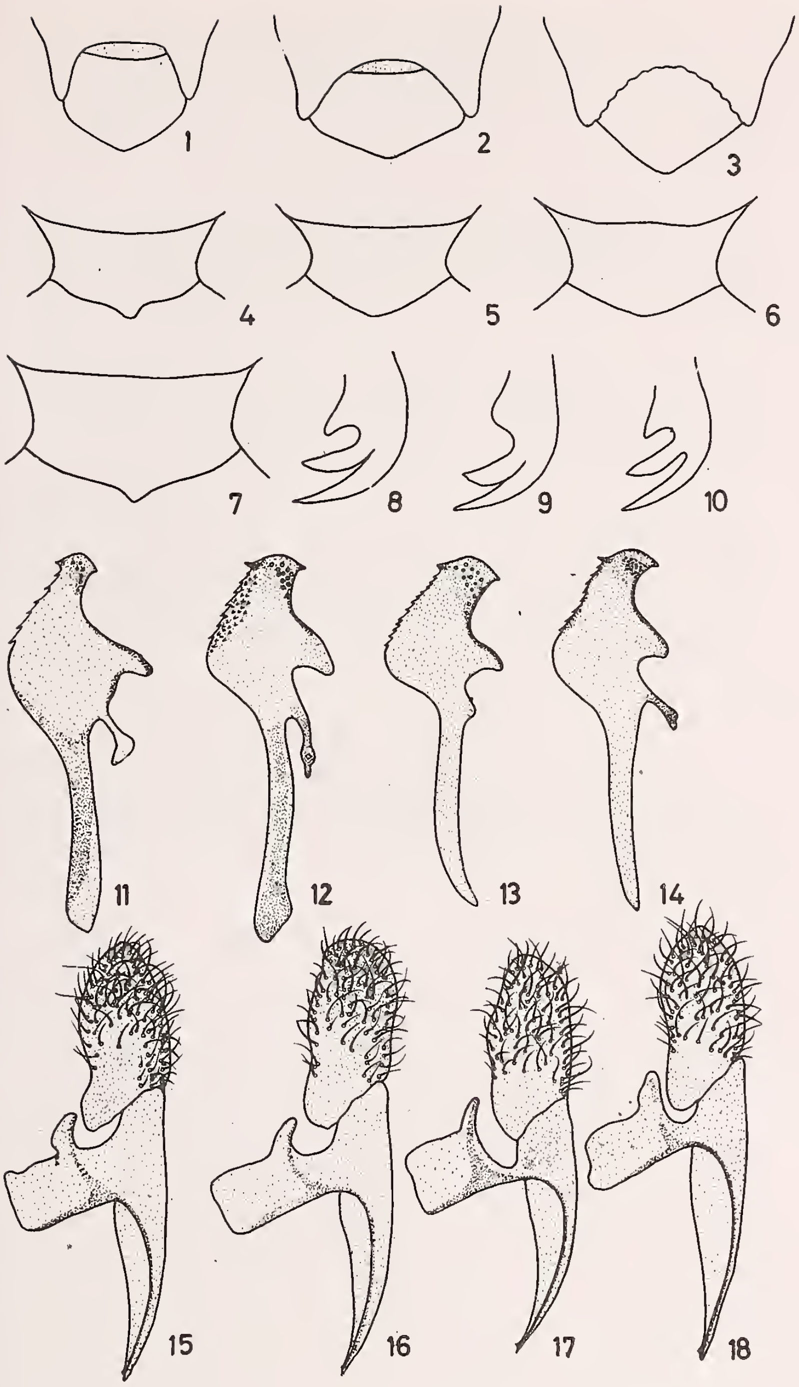
Distribution: Burma; INDIA: Meghalaya, Uttar Pradesh.

Diagnostic characters: This species is a first report from India. The specimens studied fall within Malaise's 1963 key for world genera and agrees well with the original description, by Malaise (1957). The species is unique in having antenna bicoloured; apical halves of wings infuscated; characteristic shape of median fovea; absence of lateral flecks on abdomen; mesoscutellum with a row of large punctures on its posterior border and head densely, minutely punctured. Because of the combination of these characters *I. unicolor* stands far apart from all other reported species of this genus.

Indotaxonus canaliculus sp. nov.

(Figs. 4, 12, 16, 21)

FEMALE: **Colour**: Body fuscoferruginous, whitish areas are: antennal segments 7-9. Black areas are: antennal segments 4-6; mandible tip; a spot between ocelli and covering most of frontal area; a streak along lateral furrows; ventral 2/3 of pronotum except margins; extreme anterior aspects of mesonotal middle lobe; a broad medial spot covering most of mesonotal lateral lobe; anterior aspects of mesepisternum; mesosternum except anterior margin; anteroventral 1/2 of mesepimeron; metapleuron entirely; lateral flecks on terga 2-7 (more large on terga 3-4). Legs fuscoferruginous. Wings faintly hyaline, transparent; costa and basal 1/2 of stigma fulvous; rest of venation including subcosta black.



Figs. 1-18. Species of the genus *Indotaxonus* Malaise: 1. Clypeus & labrum of *tajinderi;* 2. Clypeus & labrum of *bicoloris;* 3. Clypeus & labrum of *unicolor;* 4. Hypopygium of *canaliculus;* 5. Hypopygium of *bicoloris;* 6. Hypopygium of *unicolor;* 7. Hypopygium of *tajinderi;* 8. Tarsal claw of *tajinderi;* 9. Tarsal claw of *unicolor;* 10. Tarsal claw of *tricoloricornis;* 11. Penis valve of *bicoloris;* 12. Penis valve of *canaliculus;* 13. Penis valve of *tajinderi;* 14. Penis valve of *tricoloricornis;* 15. Gonoforceps of *bicoloris;* 16. Gonoforceps of *canaliculus;* 17. Gonoforceps of *tajinderi;* 18. Gonoforceps of *tricoloricornis*

Structure: Length 12.5 mm. Antenna long, 2.8x head width; scape twice as long as its apical width; pedicel as long as its apical width; segments 3 and 4 equal; segments 6-9 strongly compressed; clypeus (Fig. 1) subsquarely incised up to 1/2 of its medial length; labrum (Fig. 1) broader than long, ratio 3:2, with pointed anterior end; malar space 0.75x diameter of median ocellus; head with postgenal carina; hind orbits carinated; LID:IDMO:EL = 6:7:4; frontal area below the level of eyes; supra-antennal tubercles moderate and confluent with similar roundly raised frontal ridges; median fovea in the form of a deep ditch, clearly though narrowly reaching median ocellus; post-, inter- and circumocellar furrows sharp and distinct; lateral furrows deep, distinct, parallel and ending just before the hypothetical hind margin of head; postocellar area almost flat, longer than broad, ratio 3:2 and with faint medial longitudinal carina in its anterior half; head slightly narrowing behind eyes; OOL:POL:OCL = 3:2:4; mesoscutellum convex with a median longitudinal carina more prominent on its anterior half; appendage not carinate; ICD:ITD = 1:3; tarsal claw with a subapical tooth stronger but shorter than apical one and a distinct basal lobe; metabasitarsus almost equal to following joints combined; metatibial spurs subequal in length; IATS:MB:OATS = 1.25:0.4:0.75. Lancet (Fig. 21) having 31 serrulae. Hypopygium as in Fig. 4.

Sculpture and pubescence: Head impunctate, shining; thorax impunctate except mesepisternum that bears dense, deep, distinct, confluenting punctures on its convexity, surface shining with an oily lusture; abdomen impunctate less shiny. Body covered with golden pubescence.

MALE: Length 9 mm. Similar to female except black flecks on terga missing. *Male genitalia*: Penis valve (Fig. 12), gonoforceps (Fig. 16).

Holotype: Female, Uttar Pradesh: Kalamunitop-2700 m, 24 June, 1991.

Paratypes: Uttar Pradesh: 3 females, 1 male, Mandal-2300 m, 15 June, 1987; 1 male, Kalamunitop-2700 m, 24 June, 1991.

Population variation: Not observed.

Distribution: INDIA: Uttar Pradesh.

Diagnostic characters: *I. canaliculus* is unique in having some remarkable characters such as tricoloured antenna; deep ditch-like median fovea clearly, though narrowly, reaching median ocellus; wings hyaline; apical four antennal segments strongly compressed and impunctated head. On the basis of these characters *I. canaliculus* is separable from all the species dealt herewith.

Etymology: The species name pertains to the characteristic ditch-like median fovea.

Indotaxonus tajinderi sp.nov.

(Figs. 1,7,8,13,17,22)

FEMALE: **Colour**: Body fuscoferruginous; whitish areas are: apical 1/2 of antennal segment 7; segments 8 and 9 entirely. Black areas are: antennal segments 4-6 and basal 1/2 of segment 7; mandible tip; a spot between ocelli and a streak along lateral furrows; a median spot on anterior 1/2 of pronotum; a broad medial spot covering most of mesonotal lateral lobe; extreme anterior aspect of mesepisternum; mesosternum entirely; a streak on anterodorsal margin of mesepimeron; lateral medial irregular flecks on terga 3-6 (larger on 3-4). Legs fuscoferruginous. Wings faintly hyaline, transparent; costa and basal 1/2 of stigma fulvous; rest of venation including subcosta black.

Structure: Average length 10.5 mm. Antenna long, 2.8x head width; scape twice as long as its apical width; pedicel as long as its apical width; segments 3 and 4 almost equal in length; apical 3 segments strongly compressed; clypeus (Fig. 1) subsquarely incised up to 1/2 of its medial length; labrum (Fig. 1) broader than long, ratio 3:2, with pointed anterior end; malar space 0.75x diameter of median ocellus; head with postgenal carina; hind orbits carinated; LID:IDMO:EL = 4:4:3; frontal area below the level of eyes; supra-antennal tubercles and frontal ridges insignificant; median fovea in the form of a deep pit in its anterior half and posteriorly only shallowly and broadly reaching median ocellus; post -, inter- and cirumocellar furrows sharp and distinct; lateral furrows distinct, deep, parallel and ending just before the hypothetical hind margin of head; postocellar area almost flat, longer than broad, ratio 4:3, with a faint medial longitudinal carina in its anterior 1/2; head narrowing behind eyes; OOL:POL:OCL = 3:2:4; mesoscutellum pyramidally raised; appendage not carinate; ICD:ITD = 1:3; tarsal claw (Fig. 8) with a subapical tooth stronger but shorter than apical one and a distinct basal lobe; metabasitarsus almost equal to following joints combined; metatibial spurs subequal in length; IATS:MB:OATS = 1.25:4:0.75. Lancet (Fig. 22) with 29 serrulae. Hypopygium as in Fig. 7.

Sculpture and pubescence: Head impunctate, shining; thorax impunctate except mesepisternum that bears few large, shallow, confluenting punctures on its convexity, surface shining with oily lustre; abdomen impunctate, shining. Body covered with golden pubescence.

MALE: Average length 9.0 mm. Similar to female except black flecks on terga missing. Male genitalia: Penis valve (Fig. 13), gonoforceps (Fig. 17).

Holotype: Female, Uttar Pradesh: Kalamunitop-2700 m, 26 June, 1991.

Paratypes: Uttar Pradesh: 1 male, Mandal-2300 m, 15 June, 1987; 4 females, 5 males, Kalamunitop-2700 m, 26 June, 1991 and 1 female, 21 June, 1993.

Population variation: Black spot on pronotum may be missing; black spot on metepisternum and metepimeron may be present.

Distribution: INDIA: Uttar Pradesh.

Diagnostic characters: *I. tajinderi* comes close to *I. tricoloricornis* (Konow) on the basis of some broad key characters, but can be separated from the latter on account of the characteristic shape of the median fovea; postocellar area being broader than long as 4:3; OOL:POL:OCL = 3:2:4; metabasitarsus equal to following joints combined and mesonotal middle lobe without blackish spot.

Etymology: The species is named after Mr. Tajinder P. Saini, working on sawfly taxonomy at Punjabi University, Patiala, India.

Indotaxonus tricoloricornis (Konow, 1898)

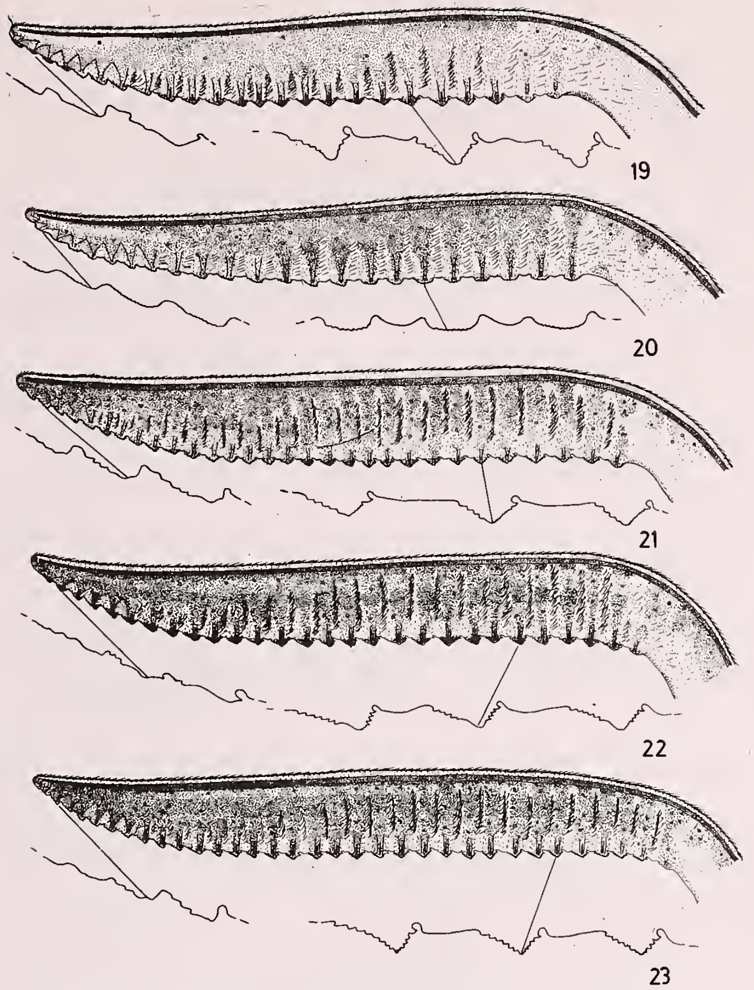
(Figs. 10,14,18,23)

Taxonus tricoloricornis Konow, 1898. Ent. Nachr. Vol. 24, p.86.

Allomorpha varicornis Cameron, 1899. Mem. Philos. Soc. Manch. Vol. 43, p. 29-30.

Indotaxonus tricoloricornis Malaise, 1957. Entomol. Tidskr. Arg. 78, H-I, p.20-21.

FEMALE: **Colour**: Body fuscoferruginous, black



Figs. 19-23. Species of the genus *Indotaxonus* Malaise: 19. Lancet of *bicoloris*; 20. Lancet of *unicolor*; 21. Lancet of *canaliculus*; 22. Lancet of *tajinderi*; 23. Lancet of *tricoloricornis*.

areas are; antennal segments 4-6; mandible tip; supra-antennal pit; spot on median fovea; interocellar area; stripe along lateral furrow; lateral spot on pronotum; anterior margin of mesonotal middle lobe and large spot on lateral lobe; broad stripe dorsal to mesopleural suture; spot on anterior margin of mesepisternum; mesosternum; metapleuron; broad dorsolateral flecks on abdominal terga 2-6 (lateral on 3-4). Wings hyaline; costa and stigma fulvous; rest of venation piceous.

Structure: Average length 10 mm. Antenna 2.5x head width, scape twice as long as its apical width; pedicel as long as its apical width; segments 3 and 4 subequal, ratio 6:7; 4 apical segments compressed; clypeus (Fig. 1) subsquarely incised up to 1/2 of its medial length with subtriangular lateral teeth; labrum (Fig. 1) broader than long in ratio 3:2, flat and with pointed anterior end; LID:IDMO:EL = 6:7:5; malar space equal to diameter of median ocellus; frontal area below the level of eyes; median fovea distinct with deep pit at anterior end and posteriorly broadly, shallowly reaching median ocellus; post-, inter- and circum-ocellar furrows sharp; lateral furrows deep, distinct, parallel and ending abruptly well before the hypothetical hind margin of head; postocellar area elevated, longer than broad, ratio 3:2, with medial longitudinal carina; OOL:POL:OCL = 3:2:3; head narrowing behind eyes; mesoscutellum pyramidally raised; appendage not carinate; ICD:ITD = 1:4; tarsal claw (Fig. 10) with a subapical tooth stronger but shorter than apical one and a distinct basal lobe; metabasitarsus longer than the following joints combined, ratio 8:7; IATS:MB:OATS = 2:5:1.25. Lancet (Fig. 23) having 34 serrulae. Hypopygium as in Fig. 4.

Sculpture and pubescence: Head almost impunctate; mesonotum minutely punctured, still shining; mesoscutellum and metascutellum polished; convexity of mesepisternum almost rugose, its remaining area and mesepisternum minutely and sparsely punctured; abdomen polished. Body covered with golden pubescence.

MALE: Average length 8.0 mm. Similar to female except the absence of flecks on abdominal tergites. *Male genitalia*: Penis valve (Fig. 14), gonoforceps (Fig. 18).

Holotype Depository: Female, IAPL, Eberswalde.

Paratype Depository: 1 Male, IAPL, Eberswalde.

Specimens examined: Uttar Pradesh: 1 female, Barkot-2000 m, 8 June, 1983; 6 males, Barkot-2000 m, 28 June, 1992; 10 females, 100 males, Mandal-2700 m, 15-17 June, 1987; 25 males, Deer Park (Mandal)-2700 m, 27 June, 1989; 3 males, Mandal-2700 m, 25 June, 1992; 10 males, Chopta-3000 m, 19 June, 1987; 6 males, Chopta-3000 m, 25 June, 1992; 1 female, Gobindghat-1800 m, 28 June, 1987; 2 females, Mukteshwar-2700 m, 20 June, 1991; 7 females, 11 males, Binayak-2225 m, 22 June, 1991; 2 males, Kalamunitop-2700 m, 24 June, 1991; 2 males, Kalamunitop-2700 m, 21 June, 1993; 3 females, 5 males, Kilbury-2200 m, 22 June 1993. Himachal Pradesh: 36 females, 30 males, Kalatop-2800 m, 30 June — 2 July, 1986; 1 female, Shoja-3000 m, 10 May, 1992. WEST BENGAL: 2 females, Pashok-2000 m, 22 May, 1987; 1 male, Darjeeling-2280 m, 7 May, 1993; 4 females, 3 males, Darjeeling-2280 m, 11 September, 1993. SIKKIM: 1 female, Gangtok-1700 m, 15 May, 1986; 1 male, Gangtok-1700 m, 14 May, 1993; 1 female, 3 males, Namchi-1700 m, 16 May, 1993. ARUNACHAL PRADESH: 14 females, Bomdila-2550 m, 2 May, 1989; 9 females, 27 males, Bomdila-2550 m, 31 May-2 June, 1989; 4 males, Bomdila-2550 m, 25 June, 1993; 1 female, Dirang-1500 m, 29 May, 1993. MEGHALAYA: 3 females, Smit-1500 m, 17 May, 1989; 5 males, Elephanta Falls-1500 m, 19 May, 1989; 5 males, Elephanta Falls-1500 m, 19 May, 1989; 2 females, Happy Valley-1500 m, 20 May, 1989. NAGALAND: 2 females, Zunheboto-1874 m, 14 May, 1993; 1 female, Satakha-1500 m, 15 May, 1993.

Population variation: There is considerable variation in the black lateral flecks on abdomen in the females. Sometimes the flecks are small just on the border leaving a yellow abdomen in between but in some cases where flecks are quite prominent and large, the yellow colour of abdomen is left only in the form of a line in the centre. Usually the number of these flecks is 6, i.e. on terga 2-7. But sometimes 5 on 2-6, sometimes, 4 on 2-5 or 3-6. In case of males the apical abdominal tergites may be fulvous to almost black or entirely pale.

Distribution: INDIA: Uttar Pradesh, Himachal Pradesh, West Bengal, Sikkim, Arunachal Pradesh, Meghalaya, Nagaland.

Diagnostic characters: The specimens studied fall within Malaise's 1963 key for genera of the world and Malaise's 1957 key to the species of this genus. They also compare well with the available description by Konow (1898). *I. tricoloricornis* (Konow) is distinct from all other species on the basis of some remarkable characters such as the characteristic shape of median fovea; tricoloured antenna; hyaline wings; black marking on mesonotal middle lobe; metabasitarsus longer than following joints combined and postocellar area broader than long as 3:2, etc.

ACKNOWLEDGEMENTS

Financial assistance rendered by US, PL-480 in collaboration with ICAR is gratefully acknowledged.

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A NEW SPECIES OF *MEDINILLA* GAUD. (MELASTOMATACEAE) FROM ARUNACHAL PRADESH, INDIA[1]

G. D. PAL[2]

(*With a text-figure*)

During plant exploration in the district of Lower Subansiri, Arunachal Pradesh, an interesting species of the genus *Medinilla* Gaud. was collected. A critical study based on the regional herbarium specimens of allied species and literature on species of *Medinilla* Gaud. has proved it to be quite distinct from species so far known. It is described here.

Medinilla arunachalica sp. nov.

M. maingayi C.B. Clarke affinis, sed differt

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[1] Accepted January 1995.

[2] Arunachal Pradesh Circle, Botanical Survey of India, Itanagar-791 111.

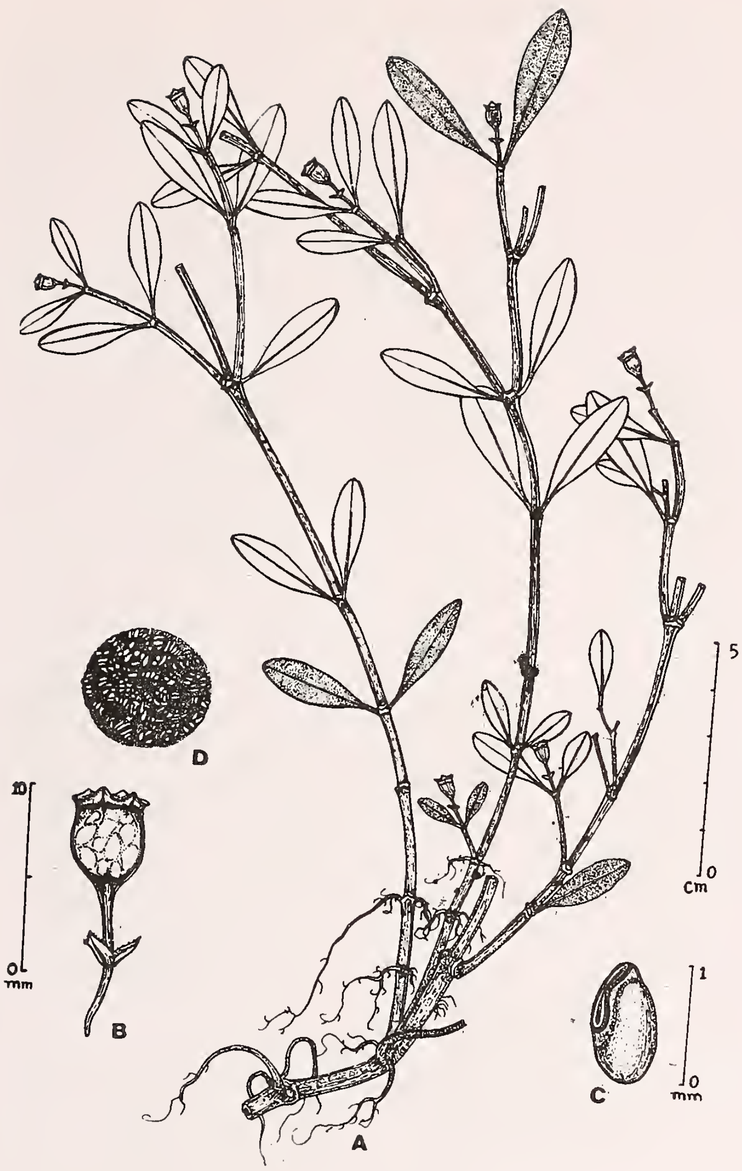


Fig. 1. A-D: *Medinilla arunachalica* sp. nov.
A: Habit; B: Capsule; C: Seed; D: Part of leaf (magnified).

foliis elliptico-lanceolatis, minus quam 1 cm latis, nervis lateralibus obscuris; petiolis 2-3 mm longis, ramis striatis sparsim verrucosis.

Typus: Old Ziro, Lower Subansiri District, Arunachal Pradesh, 1750 m, 18.9.1983, *G.D.Pal* 1232 A (Holotypus — CAL); Isotypus: *Ibid. G.D. Pal* 1232 B (ARUN).

Medinilla arunachalica sp. nov.

(Fig. 1, A-D)

Allied to *Medinilla maingayi* C.B. Clarke but can be distinguished by the leaves being elliptic-lanceolate, less than 1 cm broad; lateral nerves obscure; petioles 2-5 mm long; branches striate, sparsely verrucose.

Epiphytic scandent shrubs, 30-40 cm tall, rooting at lower nodes. *Stems* striate, sparsely verrucose, reddish brown, branchlets angular, glabrous. *Leaves* elliptic to elliptic-lanceolate, 1.2-3.2 x 0.6-0.9 cm, cuneate at base, obtuse, reflexed at margin, turn dark-brown when dry; lateral nerves obscure; midnerves strong; petioles 2-3 mm long. Inflorescence axillary, 1-2-flowered cymes; peduncles 2-4 mm long, terete, glabrous; bracts ovate to suborbicular, 1.75-2.0 x 1.25-1.5 mm, acute or obtuse, ciliolate at margin; pedicels 4.0-4.5 mm long, terete to obscurely angled. *Flowers* tetramerous; calyx 4-toothed; teeth broadly triangular, 1.0-1.5 mm long, apex obtuse, midrib more or less prominent; ovary inferior. *Fruits* berry, oval to subglobose, 6-7 mm long, 4.5-6.6 mm broad at apex, crowned with the persistent calyx-teeth, *Seeds* oblong-ellipsoid, *c.* 1 mm long; raphe extending below the middle.

Habitat: In moist, broad leaved sub-temperate forest on *Michelia* tree where it grows in hollows and rotting wood left by fallen branches, associated with *Medinilla himalaiyana* Hook. f. & Triana and *Medinilla erythrophylla* Lindl.

Fruiting: September.

ACKNOWLEDGEMENTS

I am grateful to Dr. P.K. Hajra, Director, Botanical Survey of India, Calcutta for facilities and encouragement. Thanks are also due to Dr. H.J. Chowdhery, Scientist 'SE', Arunachal Pradesh Circle, Itanagar for his help.

A NEW SPECIES OF OXYOPID SPIDER FROM INDIA[1]

G.L. Sadana and Aarti Gupta[2]

(With seven text-figures)

A new species of spider, *Oxyopes gurjanti* sp. nov. of the family Oxyopidae is described and illustrated, and *O. ratnae* Tikader has been recorded for the first time from northern India.

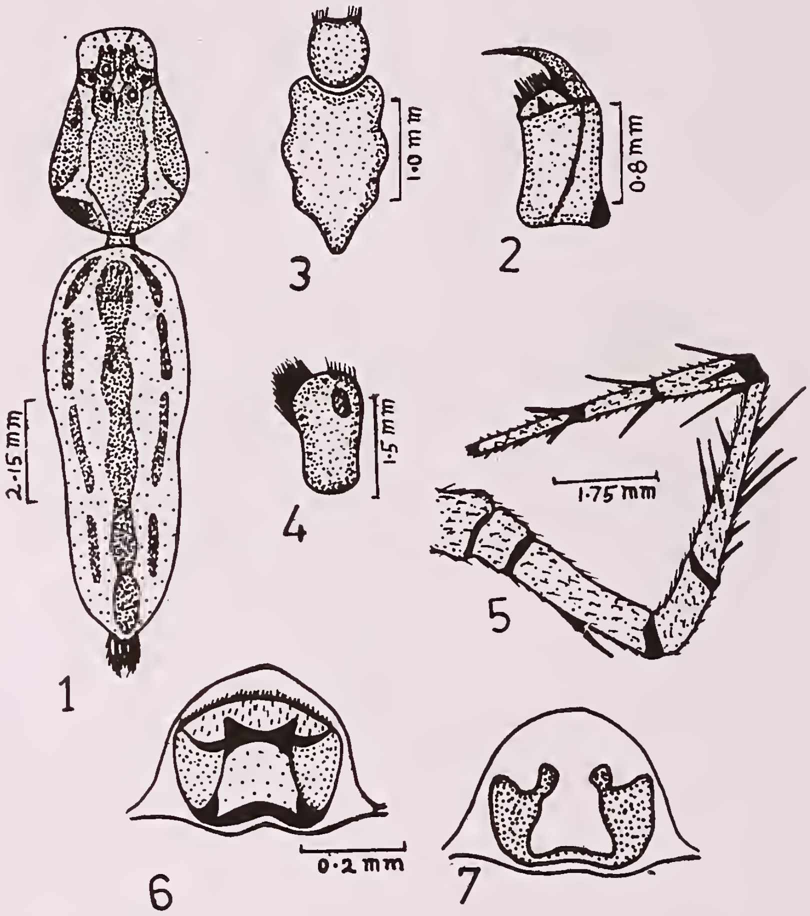
Spiders of the genus *Oxyopes* Latreille of the family Oxyopidae are little known from the Indian region. Pocock (1901) was the first to report some species of this genus but his descriptions lacked details and illustrations. Sherriffs (1951) redescribed Pocock's specimens with illustrations. Later, Tikader (1965, 1969) and Tikader and Biswas (1981) made further additions to the Oxyopid fauna of India.

While examining the collection made during the survey of spiders predaceous on insect pests of deciduous orchards, we came across two species of *Oxyopes,* one of which is new and is described here as *O. gurjanti* and the other *O. ratnae* Tikader (1970) is already known from eastern India and collected for the first time from northern India is being reported. With the addition of the new species to the already known *Oxyopes* fauna, the total number now known from India stands at eighteen.

The type specimens will, in due course, be deposited in the collections of the Zoological Survey of India, Calcutta.

All the measurements given in the decription of species are in mm.

Abbreviations are: AM, anterior median, AL, anterior lateral, PM, posterior median and PL, posterior lateral eyes.



Figs. 1-7. *Oxyopes gurjanti* sp. nov.: 1. Dorsal view of female (legs omitted); 2. Inner view of chelicera; 3. Ventral view of labium and sternum; 4. Inner view of maxillary lobe; 5. First leg; 6. Ventral view of epigynum; 7. Internal genitalia.

Oxyopes gurjanti sp. nov.

(Figs. 1-7)

Cephalothorax: female carapace length 4.02, broadest width 3.85; ground colour greyish yellow with a dark median band extending up to the eye group, flanked on either side by a similarly coloured band (Fig. 1). Cephalic region narrower and higher than thoracic region; thoracic region almost circular, thoracic fovea distinct and longitudinal. *Eyes*: pearly white, surrounded by black rims, arranged in a hexagonal manner because of strongly recurved anterior row and strongly procured posterior row (Fig. 1). *Diameter of eyes*: AM= 0.14, AL= 0.23, PM= 0.23, PL= 0.23. *Distance between eyes*: AM-AM= 0.32, AL-AL=0.97, AM-AL=0.52, PM-PM=0.95, PL-PL= 1.25, PM-PL = 0.46, AM-PM= 1.08, AL-PL = 0.45. *Clypeus*: width 0.52, yellow, marked with two dark streaks extending up to the

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[2] Department of zoology, Punjab Agricultural University, Ludhiana-141 004.

anterior median eyes and chelicerae. *Chelicera*: length 1.05, width 0.82, yellow, anterior face marked with a dark streak that merges with the clypeal streak, promargin of cheliceral furrow with two teeth, the first tooth being the largest, retromargin with a single tooth (Fig. 2), lateral condyle distinct (Fig. 2). *Labium*: length 0.68, width 0.49, yellowish brown, longer than broad (Fig. 3) extending up to more than half the length of maxillary lobes, anterior end slightly notched and beset with a few hairs. *Maxillary lobes*: length 0.89, width 0.56, yellow with a brown patch anteriorly, almost cylindrical, beset with a few hair antero-laterally (Fig. 4). *Sternum*: length 1.75, width 1.21, yellow, broader anteriorly and pointed posteriorly, significantly longer than wide (Fig. 3), sternal cones distinct. *Legs*: yellow, strong and spinose, spines standing out at a considerable angle (Fig. 5 for I), tarsal claws three. *Length of legs*: I-14.72, II-12.78, III-11.21 and IV-12.93.

Abdomen: length 8.69, broadest width 3.29, broader and rounded anteriorly, narrow and tapering posteriorly; dorsum greyish yellow with a median, reddish brown band flanked with similarly coloured oblique patches (Fig. 1). Venter pale yellow with a dark median band interrupted by yellowish spots and white mottling. Posterior spinnerets longer than anterior ones. Anal tubercle long and conical. Epigynum and internal genitalia as in Figs. 6 and 7. *Total length*: female, 12.71.

Type-data: *Holotype* female, *Paratypes* 3 females in spirit, male unknown. *Type locality*: pear orchard, Punjab Agricultural University, Ludhiana, 19.XI.1992, coll. Aarti and 29.IX.1993, coll. Gurjant.

Distribution: Known from type-locality.

Etymology: The new species is named after the collector.

Remarks: This species resembles slightly *O. pandae* Tikader but can be distinguished from it by large sized PL eyes, absence of spines in occular quad and bands on the ventral side of femura and dark bands on the venter of abdomen being interrupted by yellow spots and white mottling. The structure of epigynum and internal genitalia is also different.

Oxyopes ratnae Tikader

Oxyopes ratnae Tikader, 1970, *Rec. zool Surv. India. 64*: 70.

Material examined: 1 female, 2 males ex peach (*Prunus persica*), 9.XI.1992; 1 female, 1 male ex ber (*Zizyphus jujuba*), 11.I.1993, new orchard, Punjab Agricultural University, Ludhiana, coll. Aarti.

Distribution: INDIA: Sikkim, Calcutta, West Bengal, and Ludhiana, Punjab.

ACKNOWLEDGEMENTS

We thank the Professor and Head, Department of Zoology, Punjab Agicultural Univeriesty, Ludhiana for providing laboratory facilities and for encouragement.

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REVIEWS

1. INDIAN MARINE BIOLOGY. By G. Seshappa. pp. xxvii + 154 (24 x 16 cm), with 58 illustrations. Delhi, 1991. Daya Publishing House. Price Rs. 175/-

Man is a terrestrial creature, so it is but natural that, with a few exceptions (fortunately decreasing year after year), his inclination to learn about the sea and its activities — both animate and inanimate — may often be limited. Though India has a long coastline, most of its inhabitants live in the interior and those keen to know about marine biology had to take recourse to books written overseas, with conditions of life in the sea often somewhat different from ours. While there has been a plethora of books by Indian authors on marine fisheries, Dr. Seshappa's attempt is indeed a pioneering one, filling a lacuna badly felt by those aspiring to know about the sea and processes happening therein. In that itself, we must doff our hats to him in praise.

When I first entered the field of marine biology as a hesitating ignoramus, Dr. Seshappa was, even at that time, a venerable fishery biologist and we took to hero worshiping him — a trait common to youth. At that time, I had not read Goldsmith's confession: "I love everything that's old — old friends, old times, old manners, old books, old wine." But, subconsciously, I was following the first part. And I had always wondered why, unlike many others who take to writing almost at the drop of a hat, he had not made any contributions in the form of a book (though he has as many as 14 scientific papers). Dr. Seshappa probably felt, like Holmes, that "knowledge and timber shouldn't be much used till they are seasoned," or that "well-timed silence hath more eloquence than speech" (M.F. Tupper).

But Dr. Seshappa must finally have been inspired by Don Carlos, who said: "Nothing would ever be written if a man waited till he could write so well that a reviewer could find no fault with it."

Technically, the book is good, but I could detect a few scientific flaws. After all, "Knowledge comes, but wisdom lingers" (Tennyson), and the author has an experience of almost forty years behind him. The book can provide excellent reading for beginners, and a good source of data for those already advanced in the field of marine biology. For years, I had been searching for the scientific names of the Indian acorn worm for which Krusadai Island is noted, and which college teachers call *Balanoglossus,* a genus found in other seas. It has been correctly given in Dr. Seshappa's book—*Ptychodera flava.* Again, the scientific name of lancelet, an animal called *Amphioxus* by our college teachers, based on western forms, is given in this book; it is *Branchiostoma lanceolatus.*

There are, however, many mistakes. For example:

On page 25, there is a sentence ending "... the four equinoctial periods of the year." Actually, there are two equinoxes and two solstices in a year.

On page 28, the graph is wrong. While for July and August, the two (top and bottom) curves for "Extreme salinities" are rising, that for "mean salinities" is shown falling.

On page 32, the author states: "The limpet is abundant around the mid-tide level (ormid-beach as it may be also called)..." Limpets live over rocky substrates and not on *sand* beaches.

On page 32, the author states: "A sea anemone... settles down and grows up living permanently on the shell surface (of the empty shell inhabited by a hermit crab)". Actually, the hermit crab picks up the sea anemone and places it on the shell.

Again, on page 32, he states: "... among the smaller sizes (of limpets) and at the lower levels of the shore, the males were more numerous, while among the larger sizes and at the higher levels of the shore the females were more numerous." He conjectures that there is sex change in the limpets with growth (males changing into females), as also happens in case of some oysters. But, while oysters are sessile and remain fixed at one position, limpets can crawl. It could be equally likely that females may migrate towards the shore while males move away from the shore.

On page 33, the author states that some polychaetes secrete protective tubes of mucus, "calcium...". Actually, the tubes are made of calcium carbonate (lime).

On page 35, the author states: "These (fishes) depend on the planktonic organisms for their livelihood... being used as food by them as a group." While this may be true for plankton-feeding fishes such as sardines or mackerel, it cannot be generalised for *all* fishes. There are predatory fishes (sharks, except the whale shark, for example) which do not feed on plankton.

Tubipora (page 53) does not occur in Indian seas. (Although the author does not specifically mention that it is Indian, the way the paragraph is constructed might mislead the reader into believing so.)

On page 70, the author states: "Some (turtles) can grow to a length of 10-12 or even more feet at times...". While this may (rarely) be true for some of the land tortoises, no sea turtle grows so big. (The largest — leatherback turtle (*Dermochelys coriacea*) grows to 1.8 metres.

Again on page 70, the author states: "The entire animal can withdraw at will into the shell." While this is true for land tortoises and even freshwater terrapins, sea turtles cannot do this.

On page 71, the author says (about whales): "... certain characteristic fountains of *water* (italics mine) that they keep blowing out now and then...". Whales do not spout water; what we see is water vapour breathed out from the lungs which condenses in the cold air.

On page 71, the author states that "the common seacow is *Dugong dugon.* While this statement would be correct if there were more than one species of sea-cow in India and *Dugong dugon* was the commoner of them, it should be noted that *Dugong dugon* is the only species of sea-cow in the Old World, the other one being the manatees of America and West Africa.

On page 74, he states that "the Elasmobranchs are sea-dwellers." While this may be true for the vast majority, there are a few exceptions, like the Gangetic shark or the river sting rays of the genus *Potamotrygon* found in northern South America (Brazil and Colombia) and West Africa.

On page 82, the author states that among the Tetrodontiformes, "the spines on the body (are) the sources of poison. In several species the spines of the fins may be poisonous." While some of the fishes may have mildly toxic *venom,* the puffer fishes are known to have highly potent *poison* in the skin, liver, roe and gut.

On page 89, the author states that the mesh of the net can be... several inches in diameter from knot to knot. The meshes in a net are never round; they may be square (bar mesh) or diamond-shaped (stretched mesh).

I feel— but this is my personal opinion — that, while the material on fishes is correctly included, for, after all, fishes are constituents of marine life, the subject of fisheries which, with 40 pages makes up a large portion of the book, could have been left out, as this topic is well covered in the existing books on Indian fisheries. But I must admit that it is a good adjunct to the topics covered earlier by him and which deal with marine biology *sensu stricto.*

But, though I might sound too harsh, I feel that "in trying to ensnare an elusive, often nameless, quarry in the imperfect net of words has seemed to the author the most worthwhile enterprise he could embark on, the success or failure of the undertaking being secondary to the attempt itself." In other words, what detracts from the overall quality of the book is the way many sentences are framed.

The following sentences, in particular, while grammatically and technically correct, are clumsy.

Page 25: May reach 50 or 60 feet even.

Page 29: ... owing to some peculiar happenings in the environment.

Page 30: ... when the tide recedes in its turn.

Page 30: ... the environmental conditions acting at the time adding the deciding weight.

Page 32: The movements of the shell as carried out by the hermit crab inside it, are sufficient for the sea anemone for its own life activities.

Page 33: "Some crabs burrow holes in the sand." It should read "Some crabs burrow in the sand."

Page 33: ... Some of the echinoids are also known to show this habit among other animals.

Page 33: ... undiscovered and unworked out.

Page 63: ... the shining white cowries being liked most, perhaps.

page 70: ... and the eyes and other organs grow into the adult lamprey.

Page 70: Just at the required time the creatures are guided by mere instinct to reach some shore at any cost.

Page 71: Seals and dolphins are also subject to some fishery here and there in some seas.

Page 71: ... a pair of these dugongs were kept alive for ten years and longer. (A better phrase would be ... for over ten years).

Page 74: ...structures noticed here and there...

Page 75: ... help the fishes in perceiving the changes in the pressure of the medium and certain happenings in the surroundings.

Page 99: ... mentioned earlier above. (Should be "mentioned earlier" or "mentioned above")

A common trait of the author to end sentences with the word "also" can be irritable to the reader. An example (on page 74): ".. which have three dorsal fins also."

While on the subject of errors, let me elaborate on the author's statement (though not a mistake) on page 33 re. the discovery of the lugworm (*Arenicola*) in India. This worm was first collected off Worli (mid-Bombay city) by Mr. R.G. Dandekar, then a Junior Research Assistant at the Taraporevala Aquarium, Bombay. Before he could proceed with its study, Mr. M.R. Ranade, then Senior Research Assistant at the Aquarium, hurriedly published its occurrence. Mr. P.V. Wagh, of the Wilson College, Bombay then jumped on the bandwagon, disssected the lugworms and somehow convinced the first author of the subsequent paper (in 1959) that it was a new species. Most of the taxonomic characters of the Bombay lugworm resembled those of the lugworm, *Arenicola cristata* and *glaselli,* the major difference being that, while these forms have a statocyst with a single statolith, the Bombay lugworm had numerous statoliths. The statolith, during dissection by Wagh and Ranade, was crushed into fragments, and this difference was deemed sufficient by them to create a new species in spite of Dr. G.P. Well's comments that it was not a valid species. Many years later, subsequent dissections of lugworms collected by Mr. Dandekar have shown an intact statocyst (as in *A. cristata*), so that the Bombay lugworm is confirmed *not* to be a valid species. Incidentally, the lugworm in Bombay lives in soft mud enriched with raw sewage, as the place where it occurred is the discharge point of the sewage of Bombay city.

The illustrations of plants and animals in the book are rather crude. Moreover, there was no necessity to give (on page 103) both the left and right views of mackerel. The author could have used another fish to denote the body parts and finnage.

In the middle of page 74, the author writes: "These (Elasmobranchs) include the sharks, skates and the rays." At the foot of the same page, he states, "... in the rays and skates and also in the sharks, all of which are members of the Elasmobranchii." This is a needless repetition, and one of these sentences could easily have been dropped.

On page 34, while stating that the (sea turtle) eggs are much larger than hen's eggs, the author should have added that they are round in shape like a table tennis ball and have a soft, papery (not limy) shell.

Chapter VII, on Productivity, is too complicated for a beginner to understand.

At a first reading, I had an impression that the book had been well edited. But on more careful scrutiny, I found many spelling and typographical mistakes that have crept in. I have detected 80 such, and may have missed a few more. As they are too numerous to list here, a list will be sent to the author for correction in future editions.

A pictorial representation of currents at two seasons (pre- and post-monsoon) would have made it easy to follow the variations in current pattern.

Studies off Kerala are treated in great detail, whereas other maritime regions have been cursorily glossed over, because the author had been based there during the most creative years of his employment.

Some of the explanations have been very

simplistic, e.g. "... waste materials and nutrients washed in from the rivers... . These materials do not go unutilised, but do actively turn into very useful and rich fertilizers."

Many statements are highly generalised and tend to confuse the readers. E.g., "... may be helpful or harmful within limits depending on particular circumstances in each situation" (page 17).

On the other hand, some are so long as to again confuse the reader, on page 15: "Coming to other life requirement, it must be stated that in the shallow regions of our seas, all environmental factors including the temperature of the water, concentrations of various nutrient and other salts, concentration of dissolved oxygen and other gases, density of food items including both animals and inanimate objects, extent of water currents and wave force, and the variations in quantity of food organisms resulting from the variations and combinations of these factors from time to time, will all be having their influence in the visible total picture at any given time as well as over a period of time."

On page 19, it is stated that "The salinity ... is estimated at present by determining the chlorinity content by the titration method." This method has become old fashioned, and is largely replaced by electrical conductivity method, wherein expensive chemicals such as silver nitrate are not required.

The following statement (page 19) is also confusing:- The relative constancy of the constituents of the water... is due to the mixing up of the water by circulation or other means of physical and chemical stabilizing phenomena.

The data in the book is quite old (up to 1982-83); it could, with some effort, have been upgraded to the early nineties.

But while the above flaws can be excused, what irked several readers (whom I showed the book) is the barely disguised readiness with which the author, so to speak, points at himself. His preface has, in effect, turned out to be his autobiography. While this would have been appropriate in a foreword (which is written by a person other than the author), here it jars. He has also succumbed to the temptation of using data not very relevant to India (e.g. figs. 5 and 6 on page 26; page 32) only because it has been his research findings. He could easily have obtained similar data from India, which would have been more relevant.

But I find that I have been unduly harsh, for, though I believe.

"Take away the idea of perfection, and you take away enthusiasm."

(Rousseau)

I hope that the author will agree with me that "The greatest of faults, I should say, is to be conscious of none."

(T. Carlyle)

After all,
"Errors, like straws, upon the surface flow,
He who would search for pearls must dive below."

(Dryden)

After all, reviewing is a
"Detested sport,
That owes its pleasures to another's pain"

(W. Cowper)

So, I shall admit, like Socrates; "As for me, all I know is that I know nothing." Also,

Considering the magnitude of his task, and revering his age,

I applaud the author, and join E. Young in saying
"The purpose firm is equal to the deed;
Who does the best his circumstance allows
Does well, acts nobly; angels could no more."

And, if I can also be called a marine biologist, then
"The best of fame, a rival's praise."

(T. Moore)

To end, respected Dr. Seshappa, I emulate Shakespeare, and
"I wish you all the joy that you can wish."

B.F. CHHAPGAR

2. BIRDS OF TRIPURA — A CHECKLIST. By H.N. Mathur, I.F.S. (Retd.), D. Chakraborti, M.Sc., and T. Bhattacharya, M.Sc. Ph.D. pp. 24 (14 x 21.5 cm). On behalf of Oriole, The Tirupura Nature Club. Agartala, 1993. Tripura State Council for Science and Technology, Govt. of Tripura. Not for sale.

There have been several small publications about natural history from Assam and the Checklist of Birds from Tripura which was included in Assam not so long ago aroused an interest for comparison, but a glance at the booklet revealed that though the 3 authors are distinguished people having high educational qualifications and also having held responsible posts, presumably afterwards, the number of spelling mistakes, (185 in 24 pages) is enough to make one put it away and not bother further about it. It is marked "Not for sale" but was received presumably for review and I am making the foregoing remarks as this is about that it deserves.

HUMAYUN ABDULALI

3. THE BIRDS OF PAKISTAN. 2 Volumes. By T.J. Roberts. Vol. 1: pp. xli + 598 (27.5 x 20 cm), with 23 plates, 68 illustrations and 285 maps. Karachi, 1991. Vol. 2: pp. xxxv + 617 (27.5 x 20 cm), with 24 plantes, 16 illustrations and 284 maps. Karacahi, 1992. Oxford University Press. Price not mentioned.

This is an extraordinary contribution not only to the ornithology of Pakistan (for which it is the first comprehensive work), but in many ways to that of the Indian zoogeographical sub-region. This is especially so, since all of it comes from the pen and brush of a single, extraordinary naturalist. Tom Roberts has spent over thirty years in Pakistan and his name is synonymous with natural history studies and nature conservation in that country. With these two volumes (as also through his Mammals of Pakistan) his scientific contribution to a detailed knowledge of the fauna of this region will leave an indelible impression. It is obvious that this monumental work is much more than a collation of the vast store of information that has accumulated in journals and unpublished manuscripts. Roberts' personal involvement with ornithology is apparent in almost every account, as also in many places in the introductory chapters. I also reiterate the comment of another reviewer (in the *Ibis,* Vol. 134. 1992), who feels that Robert's apology for the few inconsistencies in layout between the two volumes was hardly necessary given the very high standard of both volumes.

The author's personal approach to systematic and nomenclatoral problems in this period of constant changes, while often suggesting interesting new ways to look at the problem will probably be the cause of some confusion among ornithologists familiar with conventional systems. It would be unfortunate if such confusion in any way restricted the general acceptance of this otherwise extremely important and useful work. At the beginning of some accounts of species which are still sources of some confusion regarding their systematic status, there is a section on 'Taxonomy' in which the author provides a very well researched, balanced and exhaustive discussion on the various views that fuel these controversies. He then outlines his own reasons for following a particular treatment, that is logical and usually based on a larger number of considerations then that used by previous authors.

The tremendous influence that Roberts has had on the development of ornithology in Pakistan is frequently evident. For example, his contributions to showing the importance of combining behavioural and morphological characteristics to arrive at an appropriate systematic status (for e.g. his joint paper with Ben King on the 'importance of accepting song pattern as species specific among the morphologically very similar scope owls').

These volumes are a rich mixture of the conventional faunal work, and the kind of field guide one always wishes one could have at hand. Since this work is the first of its kind for Pakistan which was however covered in a more general way by Ali and Ripley's INDIAN HANDBOOK, it is appropriate to make some comparisons with that work. There are about six species in the two volumes of this work that do not appear in the INDIAN HANDBOOK. The much smaller geographical area of Pakistan compared to that covered by the HANDBOOK, together with the fact that the area supports only about half as many species (660 vs. 1260) has enabled Roberts to devote considerably more space to each species account. This is indeed a very rewarding feature of each account. These are characterised by an unusual depth of description, profusely backed-up by the author's own observations, and an exhaustive review of practically all that has been published (and much that has not) on the species. It is indeed rare in a work of this kind to be provided references to several individual localities (that are further listed in a gazetteer, together with co-ordinates). These detailed accounts are well worth the considerably enlarged size of the book that has resulted. The description of vocalisations based on tape-recorded calls for over 48 percent of species (marked with an asterisk), is one of the outstanding features of this work. In groups like the swifts for example, such tape-recorded calls have greatly aided in reducing the ambiguity that arises when describing similar calls of sympatric species.

Volume one begins with a very useful and interesting section of seven introductory chapters that serve to introduce, in the context of Pakistan's environment, some general as well as more specific aspects of ornithology. In the chapter titled Ecological Factors, the author has gone to great lengths in attempting to link vegetational and other ecological features of different habitats with its characteristic birdlife. He goes on to describe some of the changes that have occurred in the distribution and abundance of some species as a consequence of man's influence on the environment over the past eighty years or so, based on bits of information in unpublished manuscripts and notes. In a similar analytical vein, he succinctly describes in separate chapters what little is known about zoogeographic aspects of bird distribution, about migration, and about the problems of pest species. There is also a chapter on birds as pests and beneficial agents, and another with a more personalised account of earlier ornithologists, including some critical remarks on the somewhat suspect methods of a few earlier contributors. Ornithologists in the subcontinent would do well to take heed of some of these remarks. Roberts also makes a very relevant observation about many old distributional records from Pakistan that continue to be accepted somewhat uncritically in the current literature, including the INDIAN HANDBOOK. In fact, as he points out, current habitat conditions in the areas referred to make it extremely unlikely that the species occur there today.

These introductory sections highlight the authors' enviable experience and acuity in observing and analysing the natural history of this region, his great familiarity with the not insubstantial literature and also with many of the most prominent contributors to the region's ornithology.

The plates are generally of a uniformly high quality although some of the postures would seem to be anatomically difficult for the bird to achieve. Several species accounts are enhanced by line drawings that depict special behavioural postures. I was particularly impressed by the plates depicting smaller passerines in which many species have been shown with an unusually life-like treatment of the body plumage, such as the bird would look if sitting with its feathers fluffed.

One of the main difficulties I had in using the book was in going directly from a plate to the full text of a species (which one has to do *via* the index). The plate number listed with the text similarly does not guide the user to a page number. It would have been very helpful for each species to have been given a serial reference number which could be used whenever it was mentioned in the text. Appendices include a glossary of terms, vernacular and technical terms and a very useful gazetteer of the many localities (including forest rest houses, small villages mentioned on collecting labels, etc.). Some obvious places that have however not been covered by the gazetteer include Las Bela and the Makran coast.

Since a very large proportion of the species in the Pakistan checklist are also represented in India, these volumes represent a very important step forward in describing what is known of the ornithology of the whole subcontinent. They are certainly a 'must have' for every serious birdwatcher in the region. Oxford University Press also needs to be congratulated in making these important volumes available at very affordable prices, and in thus continuing their longstanding commitment to publishing works of natural history.

SHAHID ALI

MISCELLANEOUS NOTES

1. WOLF *CANIS LUPUS* KILLING A GREAT INDIAN BUSTARD *ARDEOTIS NIGRICEPS*

On the morning of 15 June 1994, I was observing a pack of eight wolves in the Great Indian Bustard Sanctuary, Nannaj (17° 41' N, 75° 56' E) in Solapur district of Maharashtra State. The pack comprising six juveniles and two adults (alpha pair) was sitting/lying in a pasture of the Sanctuary. An adult great Indian bustard *Ardeotis nigriceps* (territorial male) was also roosting besides a tussock of grass, about 200 m from its display arena in the same pasture. It was the dominant male (alpha) of the area. Usually the cock used to start the courtship-display by 0600 h, when it becomes bright but because of the cloudy weather it was roosing till 0630 h. The wolves were about 100 m from the bustard. At 0630 h, the male wolf slowly moved towards the roosting bustard, pausing at a distance of about 10 m from it. Then it moved very very carefully, not letting the bustard know its presence and movement. When it reached quite close (2-3 m) the wolf jumped on the cock and caught it by one of its wings, but within seconds the bustard released itself from the grip of the wolf and instead of flying away, it started charging at the predator aggressively by raising the neck and fluffing feathers. However, the wolf was not frightened and caught it again. Soon other members of the pack, who were watching from a distance, joined the fray. The bustard was killed and torn apart within two minutes. It was tightly held by the male wolf in his mouth till the other wolves came in.

After removing the feathers, the body of the bustard was carried away by the juveniles about 150 m from the killing spot and it was eaten in ten minutes. The parent fed on the pectoral girdles and the calamus (calamii) of the flight wings. On examining the spot, these calamii were filled with fluid. The rectrices were quite heavy and appeared dark blue externally because of the presence of this fluid. The parent wolves allowed the juveniles to take the kill away from them and feed on it, but the latter quarreled over the kill with one another: a juvenile running away with the kill, followed by its companion, then another individual managing to get hold of the kill and trying to escape with it, and so on. This activity prolonged the process of finishing the kill which otherwise would have been finished within five minutes or even less time. Earlier in 1993 probably the same adult male bustard was seen to threaten four wolves when they came to the daytime resting site of the former after eating a Blackbuck *Antilope cervicapra.* The bustard had chased off the wolves at that time from its resting spot.

The same evening (i.e. 15 June) another adult male was seen in the display arena. It started displaying after 11 days at exactly the same spot which was used by the killed male. The territorial cock was killed because of its reluctance to leave the territory. Incidentally, the same spot is in use for display by bustards for the last 15 years (Rahmani 1994, pers. comm.).

I thank to Dr. A.R. Rahmani for going through the earlier version of the draft.

July 25, 1994

SATISH KUMAR

Bombay Natural History Society,
Shaheed Bhagat Singh Road,
Bombay 400 023.

2. FURTHER NOTES ON FROG-EATING HABIT OF GREY MUSK SHREW *SUNCUS MURINUS*

In my previous note (Sharma 1991, *J. Bombay nat. Hist. Soc. 88*:109), I described a grey musk shrew *Suncus murinus* attacking a *Rana tigerina* in Jaipur district. Recently, on 1.9.1993 at about 1000 h, I observed an adult grey musk shrew feeding on a *Tomopterna breviceps* in a cemented tank with no water, at Jhadol Village in Udaipur district. First, the head of the frog was bitten many times and then it started devouring the frog head first. Skin, flesh and bones were eaten. When almost one-third of the body of the frog was finished, I disturbed the shrew to collect the remaining part of the frog for identification. The frog was identified by the presence of the large and shovel-shaped inner metatarsal tubercle and half-webbed toes.

One subadult *R. tigerina* was also present in the tank which had not been attacked by the shrew. They had accidentally fallen into the tank during the previous night. *T. breviceps* is more 'sluggish' than *R. tigerina,* hence perhaps was easily attacked by the shrew.

September 6, 1994

SATISH KUMAR SHARMA

Range Forest Officer, Aravalli Afforestation Programme,
Jhadol (F.), Udaipur (Raj.) 313702, India.

3. OCCURRENCE OF THE JAPANESE PIPISTRELLE, *PIPISTRELLUS ABRAMUS* (TEMMINCK, 1840) (CHIROPTERA: VESPERTILIONIDAE) IN MYANMAR (BURMA) AND INDIA

The Japanese Pipistrelle, *Pipistrellus abramus* (Temminck, 1840) has been sporadically reported from India during the last quarter of the nineteenth century and first quarter of the twentieth century. Dobson (1876) listed a number of specimens from different localities of India, as *Vesperugo abramus.* Thomas (1886) reported this species from Manipur. Robinson (1913) recorded *Pipistrellus abramus* from two different localities of erstwhile Assam, now Assam and Arunachal Pradesh. Interestingly, there is no subsequent report of this species from India. Further, it was the general practice in those days to call any small, blackish pipistrelle from India as *Vesperugo* (or *Pipistrellus*) *abramus,* without giving importance to its relative structural and metrical characteristics. It was, therefore, felt necessary to check identification of specimens, labelled as *Pipistrellus abramus,* present in the National Zoological Collections of India, NZCI (maintained by the Zoological Survey of India, ZSI).

None of the specimens listed by Dobson (1876), as far as could be traced till date, are *Pipistrellus abramus.* Some are *Pipistrellus mimus,* others *P. coromandra.* Incidentally, Thomas' (1886) specimen of *Vesperugo abramus* from Manipur was later identified as *P. paterculus* by the same author (Thomas 1915). Of the three examples of *Pipistrellus abramus* reported by Robinson (1913), from Arunachal Pradesh (a male and a female) are still available in NZCI. These are indeed examples of *Pipistrellus abramus,* as understood by Hill and Harrison (1987), even though Robinson (loc. cit.) casually remarked that the specimens were 'typical examples of the Common Indian Pipistrelle'. A further search yielded two more specimens of this species — one from Uttar Pradesh and the other from northern Myanmar (Burma). Since *Pipistrellus abramus,* as it is understood now, has not been authentically reported from India and Myanmar (Burma) (*vide infra*), it was thought desirable to do so here. Description of the specimens are given in the following paragraphs.

Pipistrellus abramus (Temminck)

Vespertilio abramus (Temminck, 1840[1], *Monogr. Mammal.,* 2: 232, pl. 58; figs. 1, 2 (Nagasaki, Kyushu, Japan).

Material Examined: MYANMAR (Burma): 1 female (in spirit, skull extracted): North Shan State: Namkam, R.B.S. Swell, 25 Nov. 1926. INDIA: Arunachal Pradesh: 1 male, 1 female (study skins and skulls, skull of male badly damaged): West Siang district: Abor Hills (now Adi Hills): Rotung (396 m), S.W. Kemp, 10 Mar. 1912; Uttar Pradesh: 1 female (in spirit, skull extracted): Allahabad district: Allahabad, J. Cockburn, 19 Mar. 1977 [this specimen was listed as *Pipistrellus maurus* (= *Pipistrellus savii*) by Anderson 1881, who obviously, could not see the small first upper premolar as the skull was *in situ*].

Measurements: *External*: 1 male: forearm 31.4. 3 females: forearm 31.6, 33.2, 34.4; tibia 10.8, 11.9, 13.0; foot and claw 6.4, 7.5, 7.6. *Cranial*: 1 male: palatal length 4.8; maxillary toothrow (c - m^3) 4.2; molar width (m^3 - m^3) 5.0; mandibular length 8.6; lower toothrow (c - m_3) 4.6. 3 females : greatest length 12.1, 12.7, 13.2; condylobasal length 11.4, 12.5, 12.8: palatal length 5.0, 6.3, 6.4; maxillary toothrow 4.4, 4.8, 4.9; molar width 5.2, 6.0, 6.0; least interorbital width -, 3.8, 4.1; zygomatic width -, -. 8.2, cranial width 6.5, 6.6, 6.8; mandibular length 9.1, 9.9, 10.0; lower toothrow 4.7, 5.2, 5.3.

Both the specimens from Arunachal Pradesh are young adults. In the present material, both maxillary toothrow and lower toothrow are marginally longer than those of the Chinese population given by Allen (1938).

Agrawal and Sinha (1973) in their study on the baculum of some Oriental bats, identified a specimen from Indawagyi Lake, Burma, as *Pipistrellus abramus paterculus* Thomas, whose baculum they thought, was 'doubly curved'. Hill and Harrison (1987) suggested that this specimen, mentioned by Soota and Chaturvedi (1980) on the basis of Agrawal and Sinha (loc. cit.), should possibly be regarded as *P. abramus* (on account of its doubly curved baculum), rather than as *P. paterculus.* We have examined the baculum and skull of the specimen in question and have found that the curvature in the baculum is incipient, and tallies well with the figures of baculum of *P. paterculus* given by Wang (1982) and Hill and Harrison (loc. cit.). Also, dental characteristics (*vide infra*) of this specimen clearly indicate that it is an example of *P. paterculus.*

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[1] The date of publication of the second volume of C.J. Temminck's 'Monographies de Mammalogie,...', as given on the title page, is '1835 á 1841', meaning 1835 to 1841. Tate (1942) considered the date of publication of *abramus* as 1835, while Osgood (1932) gave it as 1841. Both Blanford (1891) and Wallin (1969) put this date as 1835-41. But, Ellerman and Morrison-Scott (1951), Laurie and Hill (1954) and Corbet (1978) gave the date of publication of *abramus* as 1840. For the sake of stability, we have followed these latter authors.

Pipistrellus abramus is known from Japan (excepting Hokkaido), southern Ussuri region (eastern Siberia), Korea, China (eastern, southeastern and southern areas, including Taiwan, Hong Kong, Hainan and southeastern Tibet) and Vietnam (*vide* Aoki 1913, Thomas 1928, Allen 1938, Tate 1942, Kuzyakin 1950, Romer 1960, Imaizumi 1961, Wang *et al.* 1962, Wallin 1969, Feng *et al.* 1980, Wang 1982, Hill and Harrison 1987). Lekagul and McNeely (1977) have suggested that *abramus* may occur in eastern Thailand. According to Tate (1942), the specimens recorded by Taylor (1934) from the Philippines should be referred to *abramus.* Laurie and Hill (1954) have considered the specimens reported by Shamel (1940) from Celebes (=Sulawesi) as *Pipistrellus javanicus abramus.* However, the distributional range of *abramus* given by Corbet (1978) does not include the Philippines or Sulawesi. Thus, the occurrence of *P. abramus*, as understood by Hill and Harrison (1987), in the Philippines and Sulawesi remains to be confirmed.

The specimen of *Pipistrellus abramus* recorded from Kobo, North Lakhimpur district, Assam, by Robinson (1913) could not be examined. It would, however, not be wrong conjecture to presume that this specimen also was an example of *P. abramus.*

The present specimens form the basis of first authentic record of *Pipistrellus abramus* from India and Myanmar (Burma).

The geographical distribution of *Pipistrellus abramus,* therefore, stands as — Japan (excepting Hokkaido); southern Ussuri region (eastern Siberia); Korean Peninsula; China (eastern, southeastern and southern areas, including Taiwan, Hong Kong, Hainan and southeastern Tibet); Vietnam; possibly eastern Thailand; northern Myanmar (North Shan States); northern India (Uttar Pradesh, ? northern Assam, and Arunachal Pradesh); ? Philippines; ? Sulawesi.

The Japanese Pipistrelle, *Pipistrellus abramus* and the Burmese Pipistrelle, *Pipistrellus paterculus* Thomas, 1915, which occur sympatrically in southern China, northern Myanmar (Burma) and northern India, are very much similar structurally. However, these two species can be separated by the relative size of upper incisors, relative size and position of first upper premolar and by the structure of baculum (Thomas 1915, Wang 1982). In *Pipistrellus paterculus,* second upper incisor does not attain the height of outer (secondary) cusp of first upper incisor, while in *P. abramus,* tip of second upper incisor exceeds the height of outer (secondary) cusp of first incisor. First upper premolar in *P. paterculus,* though small (equals second upper incisor in area), is well visible in lateral view; canine and second upper premolar are not in contact. In *P. abramus,* first upper premolar is quite small (its area less than that of second upper incisor), and practically concealed behind the posterior cusp of canine so that it is nearly invisible in lateral view; canine and second upper premolar are nearly or actually in contact. Baculum in *P. abramus* has a double sigmoid curvature, 10-12 mm long and its terminal prongs less developed, while that in *P. paterculus* is almost straight (with an indication of incipient curvature), more than 9 mm long, its terminal prongs well developed and form nearly a complete ring at an angle of 45° to the shaft.

Allen (1938) considered *Pipistrellus abramus* as a monotypic species, and synonymised *Vespertilio irretitus* Cantor, 1842 (type-locality: Chusan Island, Chekiang, China) and *Scotophilus pumiloides* Tomes, 1857 (type-locality: ? China) with it. Tate (1942) synonymised *Vespertilio akokomuli* Temminck, 1840 (type-locality: Japan) with *abramus;* considered *irretitus* as the mainland representative of *abramus;* referred *pumiloides* to *abramus* group, at the same time mentioned that it was virtually inseparable from the topotypes of *abramus,* and treated *paterculus* as a small representative of the *abramus* group. Wallin (1969) considered *abramus* as a polytypic species and put *akokomuli, irretitus* and *pumiloides* under the synonymy of the nominate subspecies. Corbet (1978) treated *abramus* as a subspecies of *Pipistrellus javanicus* and synonymised *akokomuli, irretitus* and *pumiloides* with *abramus.* Again, Wang (1982) considered both *abramus* and *paterculus* as polytypic species. From a comprehensive study of bacula, Hill and Harrison (1987) have established that *javanicus, abramus, paterculus,* among others, are distinct species under the *javanicus* subgroup of the *Pipistrellus* group, as recognised by them. These authors included *akokomuli, irretitus* and *pumiloides* under *abramus.* Thus, whether *Pipistrellus abramus* (as understood by Hill and Harrison 1987) is divisible into more than one subspecies can only be known when sufficient material from its vast distributional range is studied.

May 31, 1993 P.K. DAS
Zoological Survey of India; 'M' Block; Calcutta 700 053.
Y.P. SINHA
Zoological Survey of India; Eastern Regional Station; Fruit Garden, Risa Colony; Shillong 793 003; Meghalaya.

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* Not seen in original.

4. NEW DISTRIBUTIONAL RECORD OF *PETAURISTA FULVINUS* WROUGHTON, 1911 (MAMMALIA: RODENTIA: SCIURIDAE), WITH COMMENTS ON ITS TAXONOMIC STATUS

Petaurista fulvinus Wroughton, was till now known only from Shimla (Shimla district, Himachal Pradesh, India), its type-locality. During the course of a faunistic survey of Dudwa Tiger Reserve in the terai and the surrounding areas in Kheri district of Uttar Pradesh, a male specimen of this taxon was collected, while feeding on a mango tree. This constitutes the first authentic record of this form from the area, and extends its distributional range much further to the southeast.

The taxonomic status of *Petaurista fulvinus* has been a subject of controversy. Wroughton (1911) described this taxon on the basis of a single specimen. Robinson and Kloss (1918) and Ellerman (1940) maintained *P. fulvinus* as a distinct species. But, Ellerman and Morrison-Scott (1951), and Ellerman (1961) synonymized it with *Petaurista petaurista albiventer.* Ellerman (1961) remarked, "The colour distinction given by Wroughton for *'birrelli'* and *'fulvinus'* strikes me as individual variations rather than racial characteristics." However, the present specimen tallies well with the description given by Wroughton (op. cit.) for *P. fulvinus*. A detailed description of the specimen is given below.

General colour of dorsum hazel, grizzled with white on back. Parachute darker on outside edges, ochraceous rufous on shoulders and behind forearms. Ventral parts pale rufous. Individual hairs of back olive grey basally, rest bright hazel with black tip and subterminal white rings. Face same colour as that of back. Cheeks white and tinged with rufous. Muzzle whitish. Hand and feet dark cinnamon rufous all throughout. Tail a little lighter than feet, and much tinged with rufous, with some black hairs at tip.

An examination of the identified specimens (n=8) (study skins and skulls) of *Petaurista petaurista* present in the Zoological Survey of India, from northwestern Uttar Pradesh and Himachal Pradesh of India, and adjoining areas of Pakistan, reveals that the study skins can easily be divided into two groups on the basis of the dorsal coloration. In one group (consisting of five skins), the dorsal colour is darker without any trace of grizzling on the back, while in the other group (consisting of three skins, including the present one), the dorsal colour is much lighter and distinctly grizzled with white. This distinction in dorsal coloration was utilized by Wroughton (1911) in framing the key for identification of *albiventer* and *fulvinus*. Further, the hand up to fingers, and feet are black or blackish (*vs* cinnamon rufous in *fulvinus*) and a black band is present above the muzzle (absent in *fulvinus*) in the study skins of the darker group, i.e. *albiventer*. Besides, the tail of the specimen collected from the surroundings of Dudwa Tiger Reserve is less bushy than that of the specimens of *albiventer*.

A study of the skulls reveals that the occipital region is concave in *albiventer*, but more or less flat in *fulvinus*. The palate, in relation to occipito-nasal length, in *fulvinus* is shorter (50-52% *vs* above 53.5%) and the maxillary width broader (19.8% *vs* 18.9%) than that in *albiventer*.

Therefore, *Petaurista fulvinus* Wroughton, should be resuscitated as a distinct species, and should not be treated as a synonym of *Petaurista petaurista albiventer* (Gray), *contra* Ellerman and Morrison-Scott (1951) and Ellerman (1961).

Material examined: 1 male: Bankati, North Kheri Forest Division, Kheri district, Uttar Pradesh; 28 Jun. 1987; R.K. Ghose coll.

Measurements (in mm, after Ellerman 1961): *External*: Head and body 377; tail 458; hindfoot 76; ear 46. *Cranial*: Occipito-nasal 70.8; palate 35.5; nasal 21.6; upper tooth-row 16.3; bulla 13.4; zygomatic width 45.0; inter-orbital width 16.0; orbit 25.5; diastema 14.0.

Additional material examined: *Petaurista petaurista albiventer*: 1 male : Trium (*c* 2,988 m), Pakistan, 17 Apr. 1922, H.W. Wells coll.; 1 male : Murree (*c* 914 m), Pakistan, 21 Apr. 1922, H.W. Wells coll.; 2 females : Naggar, Himachal Pradesh, 29 Oct. 1958, J. Schmidt coll.; 1 male : Rahla, Kullu Valley, Himachal Pradesh, 4 Jun. 1922, H.W. Wells coll. (the first two specimens were originally identified as *P. inornata*).

Petaurista fulvinus: 1 male : Nainital (*c.* 2,286 m), Nainital district, Uttar Pradesh, 2 Jan. 1914, C.A. Crump coll.; 1 Juv. unsexed: Kumaon, Uttar Pradesh, other particulars not recorded (originally identified as *P. inornatus*).

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R.K. GHOSE
T.P. BHATTACHARYA
Zoological Survey of India, 'M' Block,
New Alipur, Calcutta 700 053.

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5. FIVESTRIPED SQUIRREL *FUNAMBULUS PENNANTI* (WROUGHTON) FEEDING ON FLEDGELING HOUSE SPARROW *PASSER DOMESTICUS*

Fivestriped squirrel *Funambulus pennanti* (Wroughton) is mainly a seed eater (Barnett and Prakash 1975, Sood and Dilber 1978, Agarwal and Dalela 1983, Prater 1988). Its dental pattern with well developed incisors is adapted for nibbling seeds/kernels.

On the morning of 2nd June 1994 at around 0840 h in the residential area of Millet Research Station, Gujarat Agricultural University, Jamnagar we were surprised to see a fivestriped squirrel pouncing on a sparrow which was sitting on the ground. Before it was caught by the squirrel, the sparrow which was originally resting on the ground made a short flight and landed about 0.5 m away. At once the squirrel followed and pounced on the sparrow. This incident was observed from about 15 m. The sparrow did not make any sound while it was caught because it was tightly caught by the head. Soon, the squirrel took its prey near to a wall situated 1.0 m away and started gnawing on it. After about two minutes we went to the site for confirmation. Seeing us moving the squirrel left its prey and ran away. The prey was a fledgeling house sparrow which looked a little too young to leave its nest. The fledgeling must have ventured out from its nest before developing its flight potential fully.

The inability of the fledgeling to fly away to safer place as well as its inexperience and ignorance about the predators around had given the squirrel an easy chance to catch it.

A close examination of the carcass revealed that the fledgeling was eaten from its lower bill. We stood away waiting for the squirrel to come and take its prey, but it did not return. So it appears that birds are not a very preferred food item to the squirrel. Later, the carcass was taken away by a house crow.

Although the fivestriped squirrel is largely granivorous rodent it has been reported to feed on insects (Krishnaswamy and Chowhan 1956). Very recently, this species of squirrel has been reported to kill and feed on redvented bulbul *Pycnonotus cafer* and also to kill whitecheeked bulbul *Pycnonotus leucogenys* and house sparrow *Passer domesticus* (Tiwari 1990). The squirrel can now be considered as a predator of fledgelings/nestlings of the house sparrow.

September 30, 1994

K.L. MATHEW
CLARAMMA LUKOSE
Millet Research Station,
Gujarat Agricultural University,
Jamnagar-361006.

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6. SOME NOTES ON THE FRUITS, SEEDS AND NECTAR CONSUMED BY THREE STRIPED PALM SQUIRREL *FUNAMBULUS PALMARUM* AT POINT CALIMERE WILDLIFE SANCTUARY, TAMIL NADU

The food of three striped palm squirrel *Funambulus palmarum* includes fruits, nuts, young shoots, buds and bark. Nectar and insects are also consumed to some extent (Prater 1980). Balasubramanian (1989) described the nectar feeding behaviour of three striped palm squirrel and its possible role in the pollination of its food plant *Rivea hypocrateriformis.*

While making observations on the plant-animal interactions at Point Calimere Wildlife Sanctuary, I could observe the three stiped palm squirrel visiting various plant species to feed on the fruits, seeds, and nectar. Altogether 50 plant species were visited by this animal (Appendix 1).

In many of the observed cases the squirrels visited

APPENDIX 1

LIST OF FOOD PLANTS OF THREESTRIPED PALM SQUIRREL IN POINT CALIMERE WILDLIFE SANCTUARY

Plant Species	Family	Parts eaten
Pachygone ovata (Poiret) Hook.f. & Thom.	Menispermaceae	Seed
Capparis zeylanica L.	Capparidaceae	Fruit
Crateva adansonii DC.	Capparidaceae	Fruit
Flacourtia indica (Burm. f.) Merr.	Flacourtiaceae	Fruit
Hygonia mystax L.	Linaceae	Seed
Glycosmis pentaphylla (Retz.) DC.	Rutaceae	Seed
Toddalia asiatica (L.) Lam.	Rutaceae	Seed
Ochna obtusata DC.	Ochnaceae	Fruit
Azadirachta indica (Adr. Juss.) Harms.	Meliaceae	Seed
Walsura trifolia (Adr. Juss.) Harms.	Meliaceae	Seed
Olax scandens Roxb.	Olacaceae	Seed
Pleurostylia opposita (Wallich.) Alston	Hippocrateaceae	Seed
Scutia myrtina (Burm.f.) Kurz.	Rhamnaceae	Seed
Zizyphus mauritiana Lam.	Rhamnaceae	Seed
Zizyphus oenoplia (L.) Miller	Rhamnaceae	Seed
Lepisanthes tetraphylla (Vahl) Radlk.	Sapindaceae	Fruit
Sapindus emarginata Vahl	Sapindaceae	Fruit
Lannea coromandelica (Houtt.) Merr.	Anacardiaceae	Seed
Pongamia pinnata (L.) Pierre.	Papilionaceae	Seed
Cassia fistula L.	Caesalpiniaceae	Pulp
Pithecellobium dulce (Roxb.) Benth.	Mimosaceae	Aril
Prosopis chilensis (Molina) S.	Mimosaceae	Pulp
Syzygium cumini (L.) Skeels	Myrtaceae	Seed
Trichosanthes tricuspidata Lour.	Cucurbitaceae	Fruit
Opuntia dillenni (Ker.-Gawl.) Haw.	Cactaceae	Fruit
Canthium dicoccum (Gaer.) Teijsm & Binnend	Rubiaceae	Seed
Canthium parviflorum Lam.	Rubiaceae	Seed
Catunaregam spinosa (Thunb.) Tirvengadam	Rubiaceae	Fruit
Ixora pavetta Andrews	Rubiaceae	Fruit
Manilkara hexandra (Roxb.) Dubbard.	Sapotaceae	Fruit
Mimusops elengi L.	Sapotaceae	Fruit
Jasminum angustifolium Vahl	Oleaceae	Seed
Jasminum auriculatum Vahl	Oleaceae	Seed
Azima tetracantha Lam.	Salvadoraceae	Fruit
Salvadora persica L.	Salvadoraceae	Seed
Carissa spinarum L. Mant.	Apocynaceae	Fruit
Cordia obliqua Willd.	Cordiaceae	Fruit
Ehretia ovalifolia Wt.	Cordiaceae	Fruit
Rivea hypocrateriformis Desr. Choisy	Convolvulaceae	Seed
Gmelina asiatica L.	Verbenaceae	Seed
Viscum orientale Willd.	Viscaceae	Fruit
Drypetes sepiaria (W. & A.) Pax & Hoffm.	Euphorbiaceae	Seed
Securinega leucopyrus (Willd.) Muell.	Euphorbiaceae	Fruit
Plecospermum spinosum Trecul	Moraceae	Seed
Ficus benghalensis L.	Moraceae	Fruit
Ficus microcarpa L.f.	Moraceae	Fruit
Ficus religiosa L.	Moraceae	Fruit
Ficus tsjakela N. Burman	Moraceae	Fruit
Dactyloctenium aegyptium (L.) P. Beauv.	Gramineae	Grain
Trachys muricata (L.) Pers. ex Trin.	Gramineae	Grain

the plants to eat the seeds. Usually, the squirrels gnaw the pericarp of the fruits and eat the cotyledons. Whenever fruits with smaller seeds are encountered the whole fruit was eaten. In the case of *Cassia fistula* and *Prosopis chilensis* which possess pods, the pulp was eaten and seeds were discarded. The squirrel visited the flowers of *Rivea hypocrateriformis* and *Catunaregam spinosa* (=*Randia dumetorum*), to feed on nectar. From the observations it is inferred that, this squirrel appears to have a significant role to play in the pollination of its food plants whose flowers it visited, but does not have a definite role in the dispersal of seeds of its food plants.

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P. BALASUBRAMANIAN
Sálim Ali Centre for Ornithology & Natural History,
Kalampalayam P.O.,
Coimbatore-641 010,
Tamil Nadu.

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7. SIGHTING OF SPINY DORMOUSE *PLATACANTHOMYS LASIURUS* BLYTH, 1859 IN PEPPARA WILDLIFE SANCTUARY, TRIVANDRUM DISTRICT, KERALA

The Peppara Wildlife Sanctuary is situated at the South West end of the Western Ghats in Trivandrum District, Kerala State (8° 7' and 8° 53' N, 76° 40' and 77° 17' E, the altitude varies from 197 m to 1,363 m). The vegetation of the sanctuary consists of moist deciduous, semi evergreen and evergreen forests.

During the study on crop damage by wild animals in the Kani tribal settlements, the skin of a Spiny Dormouse *Platacanthomys lasiurus* Blyth 1859 was found in the Chemmankala kani settlement. The Spiny Dormouse is locally known "Mutteli". Ellerman and Morrison-Scott (1951) and Ellerman (1961) have reported the occurrence of these species from the near by Bonaccord area. Rajagopalan (1968) reported this species from Shimoga in Karnataka State. Apart from this no information is available on this species.

In the subsequent field surveys carried out in the Peppara Wildlife Sanctuary, three specimens of this species were collected and their habitat was studied.

Kani tribals used to catch these animals from the nearby forests, when they need them for medicinal purposes. They identify the nests of these animals by watching the water oozing out of the holds on trees. For catching them, they either cut open the trees or blow smoke into the holes. The tribals believe that the flesh and spines of this species are a cure for respiratory diseases.

External measurements of the two specimens were:

	Subadult male (cm)	Subadult female (cm)
Head and body	11.5	13.00
Tail (with hair)	12.5 (9.5)	13.00 (9.5)
Left hind paw	2.5	2.5
Left ear	2.0	2.5

Our observation on the species revealed that it lived in colonies on live trees. The nests were found on *Terminalia bellerica, T. paniculata, Persea macrantha, Dillenia retusa* and *Careya arborea.* The animals were fed on Pepper (*Piper nigrum*), Cashewnut (*Anacardium occidentale*) and Cassava (*Manihot utilissima*). To some extent they are considered as pests of the above species.

June 11, 1994

E.A. JAYSON
G. CHRISTOPHER
Kerala Forest Research Institute,
Peechi-680 653, Kerala, India.

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8. NICHE ALTERATION BY THE CUTCH ROCK-RAT, *CREMNOMYS CUTCHICUS* IN THE ARAVALLIS

The Cutch rock-rat, *Cremnomys cutchicus* has been recorded throughout its geographical range in India from rocky habitat. It prefers to inhabit crevices in between the rocks.

During the course of our studies on the small mammals in the Aravallis, we collected 271 specimens of this species from various habitats and altitudes of the Abu hill during 1993. The Cutch rock-rat was found to be the most abundant species out of the two insectivores and 12 rodents. Surprisingly, it was also collected from the crop fields situated at 1,000 and 1,600 metres altitudes. It inhabited the surrounding rocks and also rocky outcrops inside the crop fields. During night, it invaded the fields to feed upon the standing crops of maize, wheat, millet, etc.

Because of the availability of a large number of stones in the vicinity, the farmers erect 1½ - 2 metre high walls by loosely piling the stones on the periphery of their crop fields. On a comparison of the data on the frequency of occurrence of various small mammals in different habitats and altitudes, it was revealed that from the crop fields surrounded by loosely-piled stone-walls 35 *C. cutchicus* were collected using 120 traps per 72 hours and from the fields without such walls, only 6 rock-rats were collected in 72 hours with 240 snap traps. This significant (Student's 't' test, $P < 0.05$) difference in their frequency of occurrence is due to the niche alteration by the rock-rats. Instead of living in the rock crevices, they have shifted to stay in the spaces between the loosely-piled stone-walls. Man has provided an additional niche to a wild species which has, due to human intervention in the ecosystem, become a pest of the standing crops. Besides offering extra shelter to them, man has also provided close proximity to more nutritive food. As a consequence, the prevalence of pregnancy among stone-wall dwellers has been found to be superior compared to the rock-crevice inhabiting *Cremnomys cutchicus*.

December 5, 1994

ISHWAR PRAKASH
PARTAP SINGH
A. SARAVANAN
Desert Regional Station, Zoological Survey of India,
107, Kamla Nehru Nagar, Chopasni Road,
Jodhpur-342 009.

9. SPECIES COMPOSITION OF FIELD RODENTS IN CENTRAL UTTAR PRADESH

INTRODUCTION

Surveys were carried out in different localities in five districts (Kanpur Dehat, Kanpur Nagar, Lucknow, Raebareli and Sitapur) of Central Uttar Pradesh during 1986-1988. Rodents were collected by digging 100 burrows from each locality and were identified on the basis of nucleus collection and later their identification was confirmed by the Zoological Survey of India, Calcutta.

RESULTS AND DISCUSSION

B. bengalensis was the most common (more than 50 per cent) at Bilhaur (Kanpur Dehat), Banthara (Lucknow) and Lal Ganj (Raebareli) followed by *T. indica,* while at Kalyanpur (Kanpur Nagar) and Khairabad (Sitapur), *T. indica* dominated. *M. booduga* came third in the collections made from Kanpur Dehat, Kanpur Nagar and Sitapur followed by *M. meltada,* while at Lucknow and Raebareli,

M. meltada was found in more numbers than *M. booduga. N. indica* was found at all survey sites except Raebareli ranging from 3.12 to 8.33 per cent of the total collection. Likewise, *Bandicota indica* was also collected from all places except Kanpur Dehat and Lucknow ranging from 1.61 to 2.75 per cent.

Golunda ellioti Gray 3.12 per cent and *Vandeleuria oleracea* Bennett (3.90 per cent) were also collected from Kalyanpur (Kanpur Nagar) (Table 1). It was interesting to note that *V. oleracea* occupied deserted nests of weaver birds on Babool (*Acacia nilotica*) trees and also beneath the bundles of *Arhar* crop in threshing yards at the National Sugar Institute's Farm, Kalyanpur, Kanpur. From the available literature, *G. ellioti* and *V. oleracea* appear to be new records from this region.

The order of predominance of the five species was *B. bengalensis, T. indica, M. booduga, M. meltada* and *N. indica,* recorded from Kalyanpur in present survey study and are in conformity with the findings of Srivastava *et al.* (1968) who also reported these species from this locality, but they did not mention *G. ellioti* and *V. oleracea* as reported by us in this article. Therefore, the reports of these two field rats (*G. ellioti* and *V. oleracea*) forms the first record from Uttar Pradesh. The descriptions of these two species are given below.

(A) **Bush rat**, *G. ellioti*

It is interesting to note that not a single burrow of this species could be located near threshing floors. However, in certain pockets of the farm, particularly areas covered

TABLE 1

SURVEILLANCE OF FIELD RODENTS (%) IN FIVE DISTRICTS OF CENTRAL UTTAR PRADESH

District surveyed	Total No. of rats in 100 burrows	*Bandicota bengalensis*	*Tatera indica*	*Millardia meltada*	*Mus booduga*	*Nesokia indica*	*Bandicota indica*	*Golunda ellioti*	*Vandeleuria oleracea*
Kanpur dehat (Bilhaur)	117	50.42	25.64	7.69	12.82	3.41	—	—	—
Kanpur Nagar (Kalyanpur)	128	24.20	47.65	4.68	10.93	3.12	2.34	3.12	3.90
Lucknow (Banthra)	132	53.03	18.93	12.87	6.81	8.33	—	—	—
Raebareli (Lal ganj)	124	51.61		29.83	12.09	4.83	—	—	—
Sitapur (Khairabad)	145	29.65	37.93	9.65	14.48	5.51	2.75	—	—

with shrub vegetation, some typical burrows could be traced out, which were inhabited by this species.

(B) **Long Tailed tree mouse**, *V. oleracea*

Observations on feeding behaviour of the long tailed tree mouse revealed that it shoewed a marked preference for *Arhar* pods, though other harvested crops like wheat, barley, mustard and pea were also lying in the threshing yard.

Both the sexes of this species were recovered from the deserted nests of the weaver birds found hanging on babool (*Acacia nilotica*) trees.

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August 31, 1994

A.S. BHADAURIA
Y.K. MATHUR
Department of Entomology,
C.S.Azad University of Agri. & Tech.,
Kanpur-208 002 (U.P.).

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10. HETEROGENEOUS GROUPING — A STRATEGY AGAINST PREDATION

When 501 sq. Km of Kaimur hill ranges of Uttar Pradesh was declared as Kaimur Sanctuary in 1982, the main objective of the declaration was to protect the Blackbuck and Chinkara of the area. This dry deciduous and thorny scrub forest area of Mirzapur and Sonebhadra districts of U.P. rightly boasts of being a prototype habitat of blackbuck and chinkara in U.P., Undulating rocky terrain with low soil depth can only sustain natural growth of *Zizyphus* and *Carissa* species along with nallah with grass species such as *Heteropogon contortus* (Churshat), *Saccharum spontaneum* (Kans), *Chrysopogon fulvus* (Kuch), *Vetevaria zizaniodes* (Khas), *Eulaliopsis binata* (Bagai) scattered throughout the area.

Blue bull is another predominant herbivore. Nilgai is almost equally distributed in eastern and western parts of the sanctuary. Leopard, jackal and wolves are main predators of the smaller herbivores and are distributed over the entire area of the sanctuary.

Chinkara generally does not enter cultivated areas whereas nilgai often becomes a pest to cultivated crops, but both avoid dense forests and are present in undulating terrain criss-crossed by nallahs with scanty vegetation of grass and shrubs. Blackbuck also prefers open plains avoiding dense forests. Scattered bushy growth with scanty grass cover interspersed with cultivated areas force the above three main herbivores to occupy almost the same territory in Kaimur Sanctuary.

Two noticeable observations were recorded regarding the behaviour of chinkara in this Sanctuary. Firstly, faecal stations of chinkaras coincide with the faecal stations of blue bull. It was noticed that Chinkara, whose males are territorial in behaviour (Prater 1948, THE BOOK OF INDIAN ANIMALS), excrete above the faeces of blue bull. Nilgai defecates at a particular spot, perhaps to keep the individuals together (Rajesh Gopal 1992, FUNDAMENTALS OF WILDLIFE MANAGEMENT). This coinciding of faecal stations suggest that chinkaras leave the responsibility of finding a suitable habitat to blue bulls, it may suggest that chinkaras have also adapted it to live in small herds.

Secondly, chinkaras are generally reported in homogeneous herds of 3-4 with some exceptions of up to 25. But in Kaimur Sanctuary, chinkaras were seen in heterogeneous groups with blackbucks. Big herds of about 25-35 Blackbuck and chinkara were sighted. It was observed that this heterogeneous grouping was mainly when chinkaras had their young with them. A pack of 2-3 jackals separated by about 3-4 metres from each other were also observed at a distance of about 100 metres from these heterogeneous groups of blackbuck and chinkara. Jackals are still not considered as regular predators by smaller herbivores too, and hence, presence of jackals attracts very little or no attention. The jackals move behind or sideways to the herd, and when a fawn gets separated from the herd, it is instantly killed by the pack. Another significant observation contrary to Prater's observation was that these heterogeneous groups were led by a well-built male blackbuck rather than an old and vigilant female as reported by Prater (1948). This heterogeneous grouping by chinkara suggests their inability to protect their youngs from common predators like jackals, and hence, chinkaras join with blackbucks for protection.

December 21, 1994

K. PRAVEEN RAO[1]
ABHAY K. SINGH[2]
PARAMANAND[3]

[1] *Divisional Director, Bulandshahar Social Forestry Division, Bulandshahar, U.P.*
[2]*Divisional Director, Muzaffarnagar Social Forestry Divison, Muzaffarnagar, U.P.*
[3]*Assistant Conservator of Forests, South Gorakpur Forest Division, Gorakpur, U.P.*

11. SIGHTING OF A GREAT CRESTED GREBE *PODICEPS CRISTATUS* (LINN.) NEAR BASSEIN IN MAHARASTHRA

On Sunday, May 3, 1992, while returning from a bird watching visit to Bassein Fort in the early afternoon. I stopped at Papdi Tank where I observed a bird of domestic duck size with a relatively long slender neck and a sharp pointed bill. This I recognised as a grebe having observed many at close quarters on the Bosphorous, in Turkey. The bird had a dark flattish crown to the head, an orange yellow bill with a dark upward curving line from the gape to the eye. Above the eye was white. At the back of the neck the plumage was black changing through grey to a white fore neck. Close to the waterline at the base of the neck the bird showed traces of golden brown. The back was black brown with silver grey or white at the waterline. There was no obvious tail. The bird made no attempt to dive and fed purely on the surface apparently pursuing insects. Whilst it was maneouvering it was possible to see through the green murky water that the feet were yellow.

The bird was observed for approximately 15 minutes at distances varying between 15 metres and 75 metres through 8 x 40 binoculars. A subsequent visit to the tank in late June revealed that at the time of observation the water would have been not more than 300 mm deep.

I identified this bird as a Great Crested Grebe because of the white fore neck, the dark line from gape to eye, the white above the eye and the yellow feet which are indicative of the species. There was no head adornment as would be expected for mature birds of that species at that time of year in the northern hemisphere. However, Simmons (1989) states that first year birds do not breed and this could account for the apparent winter plumage so late in the season.

The only confusion species considered was the Rednecked Grebe which has a yellow bill tipped black but this option was dismissed because the Rednecked Grebe has a dark foreneck, no white above the eye and the feet, according to Ali and Ripley (1983) are blue/black.

The Great Crested Grebe is not included in the checklist of the Birds of Maharashtra (Abdulali 1981) and the southern limit of Western India quoted by Ali and Ripley is Gujarat. This would therefore appear to be an extension of the range of the Great Crested Grebe into Maharashtra to near Bombay.

February 8, 1994

ALAN A. BEATTIE
71/C, Neha Apartments,
Juhu Tara Road,
Juhu, Bombay-400 049.

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12. OCCURRENCE OF FALCATED TEAL *ANAS FALCATA* GEORGI IN WEST BENGAL

While taking part in the Asian Waterfowl Census 1993, in January, K.M., B.B. and I visited a site known as Satragachi Jheel. There we observed the presence of one male falcated teal (*Anas falcata*). Due to haze we could not locate the presence of any female or other male falcated teals. The bird was easily identified due to the deep metalic green head which occassionally kept reflecting in the sunlight and the sickle shaped feathers on the back. It was a very aggressive bird. It kept pecking at any other duck which wandered within reach.

On January 18th 1993 a male falcated teal and two male baikal teals (*Anas formosa*) in breeding plumage were reported by Janajit Ray, a local bird watcher, from Shantiniketan. He had been reporting about the occurrence of falcated teals for last 4-5 years, but it was not confirmed. This year B.B. and A.B. visited the site to confirm his report.

I visited Daburchar, a mud flat on Matla River in January 1992. There I sighted 14 Common Shelducks (*Tadorna tadorna*) which I photographed. One of the photographs showed the Common Shelducks in flight accompanied by two Wigeons (*Anas penelope*), a common pochard (*Aythya ferina*) and an unidentified duck. I made a slide copy of the photograph and projected it on a big screen. The unidentified duck turned out to be a falcated teal.

Though considered a rare winter visitor to India, I suppose the presence of falcated teal is regular in West Bengal. A correct report was not made earlier or the bird may have been overlooked amongst the crowd of other common migratory ducks.

Thanks to IWRB for their systematic recording of migratory birds in S.E. Asia which actually revealed the occurrence of this duck in West Bengal.

February 8, 1994

SUJAN CHATTERJEE
KUSHAL MOOKERJEE
BASAV BHATTACHARYA
ANANDA BANERJEE
DB-75, Salt Lake City, Calcutta-700 064.

13. DIET OF INDIAN PEAFOWL *PAVO CRISTATUS* LINN. IN GIR FOREST, GUJARAT

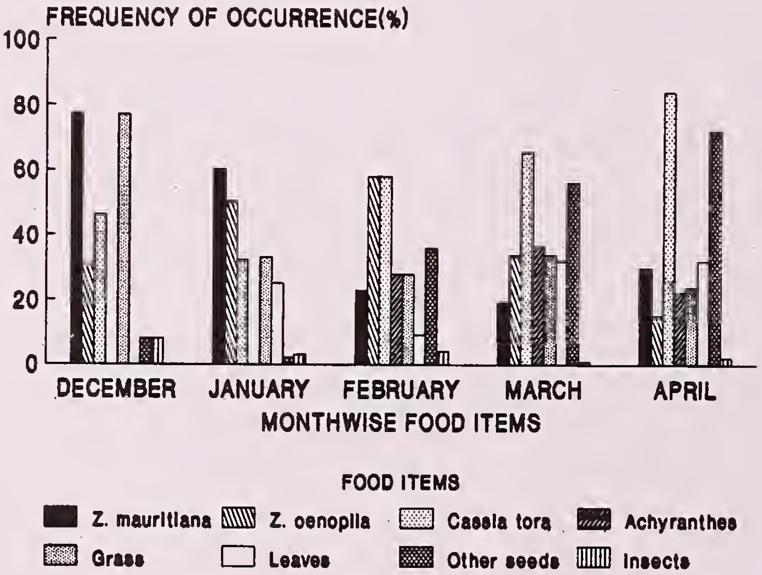
(With a text-figure)

Indian peafowl (*Pavo cristatus*), is a widely distributed and at places locally abundant bird in the Indian subcontinent. Though, it was hunted once and is a serious pest to the crops in many parts of its range, the information on its diet is largely qualitative and incomplete. Ali and Ripley (1987) and Johnsingh and Murali (1980) provided preliminary information on the diet of peafowl.

The information presented here was obtained during a study on habitat selection by Indian peafowl from December 1992 to April 1993 in Gir N.P. and Sanctuary (Trivedi 1993). Gir N.P. and Sanctuary covering an area of 1412 sq. Km, is situated in the Saurashtra peninsula of Gujarat. Tropical dry deciduous forest, thorn forest and riverine forests clothe the area. It is the last stronghold of the Asiatic lion (*Panthera leo persica*) and apart from the lion has a diverse vertebrate faunal assemblage.

Four hundred and twenty eight droppings of peafowl were examined for food remains by breaking open fresh dry droppings. Remains were noted in the form of frequency of occurrence.

Results (Fig. 1) show that during winter, i.e. December and January, the diet was dominated by fruits of *Zizyphus mauritiana* and *Z. oenoplia*. In February, there was a sharp decline in the consumption of *Z. mauritiana* whereas *Z. oenoplia* was still being consumed heavily. This was due to the fact that the peak fruiting season of *Z. mauritiana*



N=DEC-13,JAN-60,FEB-110,MAR-110,APR-135

Fig. 1. Diet of peafowl based on dropping examination.

is from November to mid January as compared to *Z. oenoplia* which reaches the peak of fruiting in late January to February. Both these berries were consumed less in March and April as they were only available in the form of old, dried up, fallen fruits. The picture of overall diet in summer changed totally with seeds of *Cassia tora, Achyranthes aspera* and other seeds dominating the diet. This is a lean period for peafowl as far as the availability of fruits, tender leaves and green grass is concerned.

In December, as grass was still green, its consumption was high. Grass should have been a major component of the diet in the months of August-November when it is tender. Insect and other animal remains were rarely found during all the months which points to a less availability of animal food during winter and summer.

The overall pattern of diet composition suggests that there is a close relationship between resource availability and utilization. The use of *Cassia tora* and *Achyranthes aspera* seeds facilitates the successful survival of peafowl around human habitations where these weeds abound. It also gets plenty of crops grown in the cultivated lands. Peafowl can be regarded as diet generalists as they exhibit granivory, frugivory, insectivory and herbivory. However, during the dry seasons of winter and summer in dry deciduous forest ecosystems, the peafowl should chiefly be a primary consumer as in Gir. *Zizyphus* is a keystone species in Gir not only for peafowl, but also for the wild ungulates and therefore management programmes should ensure the regeneration and sustained availability of this crucial resource. *Cassia tora* is another equally important resource for peafowl as it provides food during the lean period of early summer. *C.tora* is regarded as a weed in many Protected Areas (PA) of India, but this herb is a vital dietary item for peafowl. The ability to exploit many niches in the trophic level and inclusion of a large number of food species might have made it possible for peafowl to occupy such a large range in the country.

February 7, 1994

PRANAV TRIVEDI[1]
A.J.T. JOHNSINGH[2]
[1]*WWF-India, Ahmedabad Divisional Office, 'Sundarvan'; Ahmedabad-380 015.*
[2]*Wildlife Institute Of India, P.O. Box # 18; Dehradun-248 001.*

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14. NOTES ON PRIMARY MOULT IN THE REDNECKED PHALAROPE *PHALAROPUS LOBATUS* (LINN.)

Information about moult in the Rednecked Phalarope *Phalaropus lobatus* is scarce due to their largely oceanic distribution away from the breeding grounds (Prater *et al.* 1977, Etheridge 1980, Cramp and Simmons 1982, Gavrilov *et al.* 1983). There is even less information regarding post-juvenile moult, and published accounts regarding replacement of remiges are conflicting.

Prater *et al.* (1977) state that in first-winter birds the primaries are 'moderately worn by late winter. (Primary moult from January has been noted by Stresemann [Stresemann and Stresemann 1966] but we have no evidence of it on the few birds examined)'. They further note that in first-summer Rednecked Phalaropes 'Primaries very worn. Some attain summer plumage'. Hayman *et al.* (1986) also state 'The primaries are not replaced during the first winter and become very worn'. Since adults have a complete post-breeding moult in late autumn/winter (Prater *et al.* 1977, Cramp and Simmons 1982) this should allow the ageing of birds in spring/early summer based on primary wear — adults having only slightly worn primaries.

Schamel and Tracy (1988), however, found that adults and 'yearlings' (first-summer birds) could not be distinguished by primary wear on the breeding grounds in western Alaska, and further noted that J.D. Reynolds had recorded no noticeable primary wear in 'yearlings' in Manitoba, Canada. Although these authors did not relate their observations to there being a complete (i.e. including remiges) post-juvenile moult, this is the obvious implication. Hilden and Vuolanto (1972) also noted first-summer birds as being indistinguishable from adults in Finland.

Juvenile Red-necked Phalaropes are easily distinguished from adults by having a dark brown mantle 'with prominent gold-buff fringes to the scapulars and tertials'. In the autumn and early winter juveniles moult many of their body feathers so that the mantle becomes largely grey, but the scapulars and tertials may be retained to the spring but the golden-buff fringes fade to pale yellow (Prater *et al.* 1977). The inner median coverts of juveniles have rich gold fringes but these quickly fade and abrade on the outer part of the feather. Of 9 juveniles in the BNHS collection obtained in autumn from Baluchistan, Kutch and Saurashtra, the inner median coverts vary from slightly worn (2 September) to the outer fringe being very worn/faded (30 October). Although the outer fringe of the inner median coverts is lost quickly the inner fringe, which is largely protected from sunlight by the overlying feathers, retains its colour much longer and allows the ageing of birds in an advanced state of moult of the upperparts.

A small number of Rednecked Phalaropes were caught in 1983/84 at Point Calimere, Tamil Nadu (10°18' N, 79°51' E) during the BNHS Avifauna Project. Notes on these birds are given below. Primary feathers are scored from 0 (old feather) to 5 (fully grown new feather), with 1,2,3 and 4 being intermediate stages of feather growth (Ginn and Melville 1983). In the case of juvenile birds 'old' feathers may be only a few months old, whereas in adults they will be about one year old. Feather tracts are recorded from left (inner) to right (outer), thus a moult score of 1^20^8 means that the inner two primaries were new 'pin' feathers just emerging (score 1), and the outer eight primaries were old feathers (score 0). The very small, outermost (11th) primary was ignored.

Juveniles: 19 November. 1^20^8, Left = Right (i.e. moult symmetrical). Old primaries slightly worn. Well advanced in body moult; lesser and median coverts 'juvenile' dark grey brown with worn pale fringes; tertials in active moult; mantle feathers grey with broad white tips and edges, and a few black feathers on upper back. One inner median covert with pale yellow edge. This bird was recaptured on 24 November, when primary moult had progressed and scores were: L. $3^12^10^8$, R. $3^12^11^10^7$

19 November. $5^53^10^4$, L = R. Old primaries slightly worn.

24 November. 0^{10}. Old primaries moderately worn. One inner median covert with trace of yellow. Mottled back. A few black feathers on crown.

24 November. 0^{10}. Old primaries moderately worn. Trace of gold remaining on scapulars. Few black feathers on crown.

26 November. 0^{10}. Old primaries moderately worn. One inner median covert with yellow fringe on inner web, worn away on outer web.

28 November. 5^30^7, L = R. Old primaries slightly worn. One old inner median covert with pale gold fringe. Back in active moult, a few old brownish feathers with pale tips remaining. Forehead all white, active moult.

Adults: Three adults were also caught. All three had very worn primaries. Primary moult details were:

24 November. $5^44^10^5$, L = R.

24 November. L. $5^44^11^10^4$, R. $5^34^13^11^10^4$

28 November. $5^22^11^10^6$, L = R.

Three birds of indeterminate age were caught having completed their primary moult (5^{10}), one on 28 February and two on 5 April (one of these latter being the adult caught in active moult on 28 November).

From the foregoing, it is apparent that at Point Calimere at least some juvenile Rednecked Phalaropes undergo a complete moult at much the same time as adults (N.B. The second juvenile caught on 19 November was in a more advanced state of moult than the adult caught on 28 November). Ali and Ripley (1983) state that the Rednecked Phalarope is a 'Winter visitor. Common offshore... sometimes within a few miles of land but more often well out to sea at 10 to 40 or more miles from the coastline', thus it might be considered that birds caught on the coast at Point Calimere might be 'abnormal' in some way. However there is no evidence to support this suggestion, and the birds caught were in good condition (e.g. the two caught on 19 November weighed 38 and 37 g).

Much remains to be learned regarding moult in this rather elusive species.

ACKNOWLEDGEMENTS

I am grateful to the late Dr. Salim Ali and to S.A. Hussain for inviting me to join the BNHS Avifauna Project, and to Dr. R. Sugathan for his hospitality and assistance.

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DAVID S. MELVILLE
World Wide Fund for Nature, Hong Kong,
GPO Box 12721, Hong Kong.

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15. DISTRACTION DISPLAY IN THE LITTLE BROWN DOVE *STREPTOPELIA SENEGALENSIS* (LINN.)

On 5 April 1993, during bird census at Rollapadu Wildlife Sanctuary, Andhra Pradesh, I came across a little brown dove *Streptopelia senegalensis* sitting on a termite mound. As I came closer, it flew to the ground nearby and ran about on the ground with flapping wings feigning injury. It flew off when I walked towards it and perched on a nearby bush seemingly fit. Again on 23 April, I came across another dove, about 200 m from the earlier seen dove, which behaved similarly. In both cases, I made a search for nests both on the ground and in surrounding shrubs, but was not successful.

Distraction display is mostly seen in ground nesting birds (see Morris 1990). Hence what could be the cause for an arboreal species to behave likewise? Could it be that the two birds had nests on the ground that I failed to locate?[1] Both distraction display and ground nesting are not reported in the little brown dove (Ali and Ripley 1983, Cramp 1985, Goodwin 1983 and Roberts 1991)

November 27, 1993 RANJIT MANAKADAN

Bombay Natural History Society,
Shaheed Bhagat Singh Road,
Bombay 400 023.

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[1] See note no. 16 — Eds.

16. GROUND NESTING IN THE LITTLE BROWN DOVE *STREPTOPELIA SENEGALENSIS* (LINN.)

There is a no record of ground nesting in the little brown dove (Ali and Ripley 1987, Cramp 1985, Goodwin 1983, Roberts 1991).

On March 27, 1993 while censusing birds in a dense plantation 30 km north of Solapur, Maharashtra, I flushed a little brown dove *Streptopelia senegalensis* from the ground. The haphazard flight of the bird at once made me suspect the presence of the nest. On further investigation, a nest with two eggs was found on the ground at the base of a 2.5 m *Acacia catechu* tree: the nest touching the stem of the tree. After I moved out of the area, the bird returned and sat on its nest. The other tree species in the plantation were *Acacia leucophloea, A. nilotica, Albizia lebbeck, Leucaena latsiliqua, Dalbergia sissoo* and *Gliricidia maculata.* Incidentally all the trees in the plantation were leafless. There could be three possible reasons for selecting this site by the species for nesting on the ground:

1. To avoid predation since the visibility was high because of defoliation. 2. To remain in the shade of the tree. 3. To avoid blowing away of the nest by wind due to openness.

February 2, 1994 SATISH KUMAR

Bombay Natural History Society,
Hornbill House, Shaheed Bagat Singh Road ,
Bombay-400 023.

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17. AN INSTANCE OF PLAY BEHAVIOUR IN BLACK DRONGO *DICRURUS ADSIMILIS* (BECHSTEIN)

The Black drongo *Dicrurus adsimilis,* might possibly be the most agile, courageous and playful of all our common birds.

While watching birds in a small patch of scrub jungle at Aakkulam (13 km from Trivandrum city) on 7.11.93, a peculiar behaviour of two Black drongos caught my attention. The birds, both of which were juveniles, were seated on two branches of a cashew tree (*Anacardium occidentale*) about 3 m above ground. One of them was repeatedly scolding the other one in harsh notes, the head being bowed down with every call note. This bird can be assigned a symbol (A). The second bird (B) replied promptly and this verbal cacophony continued for some time. Then the bird (A) plucked a dry leaf from a nearby branch, and bending calmly, dropped it deliberately. The other one (B) quickly went after it twisting and turning gracefully, following the leaf in its spiral path downwards. Just as the leaf was a foot from the ground, the drongo darted at it and catching in its feet, transferred it to the beak and returned its perch, all in one clear graceful motion. Now it was the turn of (B) to drop the leaf and (A) to retrieve it. This fascinating play continued for the next two minutes after which the drongos, presumably losing interest in the game flew away, one chasing the other, both twisting and turning sharply and uttering harsh calls.

March 21, 1994

MANOJ V. NAIR
34 Thoppil Nagar, Kunarapuram,
Trivandrum, Kerala-695011.

18. NOTES ON THE OCCURRENCE OF THE YELLOWTHROATED BULBUL *PYCNONOTUS XANTHOLAEMUS* (JERDON) AT SHEVAROYS, TAMIL NADU

While stationed at Yercaud (11°47' N, 78°12' E) for five months as part of a project on the Indian Tree Shrew *Anathana ellioti* funded by World Wildlife Fund — US through World Wide Fund for Nature — India, Tamil Nadu State Office, I had the opportunity to observe the Yellowthroated Bulbul *Pycnonotus xantholaemus* a species endemic to South India.

Yercaud is situated 28 km north of Salem town. Yercaud is the main town in Shevaroy hills which form a major component of the southern section of Eastern Ghats. The plateau atop Shevaroys is almost entirely under coffee. The habitat where observations were made was a dense scrub and degraded deciduous forest with rock outcrops at the edge of a coffee plantation on the southern slopes of Shevaroys, about 2 km from Yercaud.

The species was first seen during a preliminary trip in January 1992. Between January and July *P. xantholaemus* was seen on 13 occasions and heard several times. Of these the species was sighted once during the preliminary surveys and twelve times during the actual project period between 10 February 1992 and 10 July 1992. On eleven occasions *P. xantholaemus* was seen along the southern slopes of Shevaroys which also happened to be the study area for the tree shrew project. But for an individual bird that was seen along the ghat road connecting Salem and Yercaud at an altitude of about 1000 m above MSL on 14 March, all the other sightings and observations were made at an altitude of about 1200 m above MSL.

When the species was first sighted on 30 January 1992 along with J.N. Prasad, a single bird was seen in the company of a pair of Fairy Bluebirds *Irene puella* that were seen feeding on *Ficus* sp. The bulbul was seen flycatching at the base of the same tree which was growing out from a dark rock crevice.

Two birds were seen on 22 March, of which one was seen carrying a dry twig. Later in the day an individual of the species was seen chasing another one. On 25 March, fibres from the bark of *Firmania colorata* were collected by an individual following which the pair flew away. Again on 25 March one pair was observed feeding the other with a fruit of *Canthium dicoccum* and the behaviour appearing to be typical of courtship feeding. Since the bird which was being fed did not adopt begging posture it was assumed that both the birds were adults and belonged to a pair. Such feeding activity is considered to be a prelude to the commencement of breeding (Welty 1982).

Further, the birds were seen feeding on *C. dicoccum* thrice and on *Ficus nervosa* once. On all the occasions they were seen in pairs. On 13 April a bird which was sitting on a huge boulder flew up on the trunk of a *Anogeissus latifolia* tree and perched upright in a manner typical of woodpeckers.

The present report of *P. xantholaemus* is the first ever of the species from Shevaroys. The observation on the food habits indicates that *C. dicoccum* and *F. nervosa* are two new food sources of Yellowthroated Bulbul not recorded earlier. Also, the fact that the birds were indulging in courtship feeding and carrying nesting material indicate nesting activity of the species, and this also happens to be the first ever record of the species breeding outside their designated nesting period as recorded by Ali and Ripley (1987) and Allen (1908). It appears that at Shevaroys the species commences its breeding activity as early as March.

February 14, 1994

S. KARTHIKEYAN
24, Opp. Banashankari Temple
8th Block Jayanagar P.O.
Bangalore-560 082.

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19. STONE CHAT *SAXICOLA TORQUATA* (LINN.) IN KERALA

According to SYNOPSIS (S.D. Ripley 1982, BNHS, Bombay) the distributional range of the race *indica* of *Saxicola torquata* extends to southern Karnataka in the Indian peninsula. Baker and Inglis in BIRDS OF SOUTHERN INDIA (1930, Madras Government Press, Madras) state that this race occurs in winter in the hills of north Mysore and Travancore, quoting Stuart Baker, though they did not find it anywhere in the Madras Presidency. Sálim Ali did not include this species in BIRDS OF KERALA (1969, Oxford Unviersity Press, Delhi) nor is it included in A BOOK OF KERALA BIRDS (Neelakantan, K.K. *et al.* 1993, WWF-India, Trivandrum).

On 19 October 1993, during a birdwatching trip to Kattampalli (11° 55' N; 75° 20' E), a wetland near Kannur, we came across two pairs of Stone Chats-two males and two females. Three of these were perched on small bushes (*Crotalaria* sp.) and grass tussocks on the bund at the water's edge. One male could be observed clearly for a long time as it perched on top of a mound of straw in the field, making short ariel sallies to catch insects like a flycatcher.

The male birds appeared to be in the autumn moult — the black of head and throat had changed in dark rufous except for an eye-streak from the lores to the ear-coverts. They had rufous breast, black tail tipped buff and white upper tail-coverts. The female birds were light brownish overall with streaked upperparts, buffish white underparts, black tail and pale rump and upper tail-coverts. The white half collar on either side of the neck in the male birds was clearly visible. The white wing patches were not visible on closed wings, but could be clearly seen when the birds flew. The birds were seen flicking their wings and tail frequently.

One of us (CS) has been regularly visiting Kattampalli since 1980, but never came across this species before. This is the first record of this species in Kerala to the best of our knowledge.

February 14, 1994

C. SASHIKUMAR
JAFER PALOT
T. PRAVEEN
9 Subhash Nagar, Kannur 670 002, Kerala.

20. WINTERING OF INDIAN BLUE CHAT *ERITHACUS BRUNNEUS* (HODGSON) AND PIED GROUND THRUSH *ZOOTHERA WARDII* (BLYTH) AT NANDI HILLS, SOUTH INDIA

Nandi Hills (13° 22' N, 77° 41' E), a popular hill resort and picnic spot in Kolar district, Karnataka is located about 60 km north of Bangalore. Known also as the Nandi Durg, it is the tallest hillock (1435 m above MSL) within the 28.37 sq. km Nandi State Forest and supports a rich variety of flora and fauna (Boraiah and Fatima 1970, Ali 1942, Ghorpade *et al.* 1974).

The hill-top plateau of Nandi Hills has a small patch of evergreen forest with coffee plantations. *Coffea arabica, C. iginoides* and *C. robusta,* which appears to

TABLE 1

DETAILS OF *E. brunneus* AND *Z. wardii* SIGHTED AT NANDI HILLS

Date of visit	Area	Number of birds sighted *E. brunneus* Male	*E. brunneus* Female	*Z. wardii* Male	*Z. wardii* Female	Observers
29 March 1991	Coffee plantation	3	1			JNP, SS
	Water's edge in evergreen patch			1		JNP, SS
30 March 1991	Coffee plantation	1				JNP, SS
	Water's edge in evergreen patch			1		
17 April 1991	Coffee plantation		4			LS *
5 November 1991	Coffee plantation	1	1	2	1	LS *
10 November 1991	Coffee plantation			1	1	JNP, SK
	Nursery	1	1			JNP, SK
22 December 1991	Nursery	1	1			JNP, SK
9 January 1992	Nursery	1		1		JNP, SK

* LS = L. Shyamal *pers. comm.*

have been planted by the Britishers after the conquest of the hill in 1791 now grows in a wild state and is not harvested. Coffee mixed with other shrubbery provides an ample undergrowth offering an ideal habitat for thrushes. In fact, species like Blue-headed Rock Thrush *Monticola cinclorhynchus,* White-throated Ground Thrush *Zoothera citrina cyanotus,* Black Bird *Turdus merula,* Indian Pitta *Pitta brachyura* can be frequently seen in the season. Adjoining this patch is a horticultural nursery spread over about an acre and is maintained by the State Horticultural Department. With its dense tree canopy, the area provides adequate shade for maintenance of potted plants.

The previous avifaunal surveys at Nandi hills (Ali 1942, Ghorpade *et al.* 1974) do not report the occurrence of two bird species, namely the Indian Blue Chat *Erithacus brunneus* (Hodgson) and Pied Ground Thrush *Zoothera wardii* (Blyth). In this article, we report our observations on the two species made at Nandi hills.

A total of seven visits were made to the area as a part of a much larger avifaunal survey of the hills (e.g. Subramanya *et al.* 1991) between March 1991 and January 1992 and a total of twelve *E. brunneus* and eight *Z. wardii* were sighted. The details on the visits, habitats where the birds were seen and their sex by different observers are presented in Table 1.

INDIAN BLUE CHAT: On all occassions when the species were seen, the birds were observed moving about within the two areas, namely the evergreen patch and the nursery, often foraging among leaf litter looking for hidden prey. These areas frequented by *E. brunneus* were shared by *P. brachyura, Z. citrina, M. cinclorhynchus* and the Tailor Bird *Orthotonus sutorius.*

On 30 March 1991, a male *E. brunneus* was observed giving out a triple noted call and as if in response a *P. brachyura* that foraged in the area also started calling. A little later another male was osberved in the horticultural nursery calling (towards a female?) as it moved among the pots. When a female approached closer, the male started to call loudly, opening and closing its wings that were held drooping. The male also kept twitching its tail up and down constantly. When it approached too close, the female chased the male and resumed foraging. The male flew up to a nearby branch of a *Salix tetrasperma* tree and started calling. Later it alighted on the ground.

A male was again observed calling and displaying similarly two hours later in the same area but no female could be seen anywhere close by. Also, the displaying male was observed chasing away a foraging *O. sutorius* and *M. cinclorhynchus* when perched close by.

However, on 22 December 1991, a female was observed promptly answering the high pitched call note by a male, with a single short note (*tweet*). Upon disturbance the male flew up to an overhanging branch and started swaying from side to side while uttering a low *kit-kit-kit-kit..* call.

Pied ground thrush: A male of this species was first sighted at Nandi hills on 29 March 1991 by two of us (JNP, SS) busily foraging, overturning fallen dry leaves along the edge of the Pathalaganga, a small pond between the evergreen patch and the nursery. Later it was seen along the edge of yet another large pond Amruth ganga, a water tank constructed in stone with steps going down to the bottom. the male was observed foraging amidst fallen leaves unmindful of a Spotted Babbler *Pellorneum ruficeps* and Magpie Robin *Copsychus saularis* in the same area and on the next day it was foraging along with *E. brunneus*. It was observed tossing dry leaves most of the day along the water's edge. Once it was noticed hopping amongst pots in the nursery and also once in the coffee plantation.

The species was again observed in the same area between 5 November 1991 (L. Shyamal, pers. comm.) and 9 January 1992 (see Table 1).

Both the species discussed above, winter in Sri Lanka. In addition *E. brunneus* is also known to winter in the hills of western India (Ali and Ripley 1987). Also both the species have been observed in passage at Bangalore (Karthikeyan 1992, Prasad and Srinivasa 1992, Shyamal 1989). *Z. wardii* has been reported as wintering at Yercaud in the Shevroy hills, Tamil Nadu (Kazmierczak 1991). Our observations on the continued presence of the individuals of the species during winter and early summer at Nandi hills clearly indicate that the individuals were those spending their winter. Thus, Nandi hills happens to be hitherto unknown winter quarters of both *E. brunneus* and *Z. wardii.*

Also, though the frequency of sightings of females were less, our observations on the occurrence of both the sexes of *E. brunneus* together at Nandi Hill refutes the claim made by Khan (1980) that both the sexes of *E. brunneus* do not move together and that females spend their winters away from males.

February 8, 1994

J. N. PRASAD
Merlin Nature Club,
No. 13, 8th cross, 30th main,
J.P. Nagar I phase, Bangalore-560 078.

S. KARTHIKEYAN
No. 24, opp. Banashankari Temple,
8th block Jayanagar P.O.,
Shakambarinagar, Bangalore-560 082.

S. SUBRAMANYA
HPHT scheme, J-Block, University of
Agricultural Sciences,
G.K.V.K. campus, Bangalore-560 065.

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21. SIMPLIFIED FIELD TECHNIQUE FOR OBTAINING BLOOD FROM FRESHWATER TURTLES

Studies on the biochemical and molecular aspects have now been recognised as essential components of the conservation programme of species. The choice of tissue in such studies has invariably been blood and this has necessitated researchers to look for the best procedure for field sampling without harming or sacrificing the animal.

Several methods have been proposed to obtain uncontaminated blood, each having its merit restricted to the species under study or to the specific experiment. The most common method of collection of samples of blood in reptiles has been cardiac puncture (Gandal 1958, Stephens and Creekmore 1983) but is less popular for turtles because of their thick plastron. Cutting off the tip of the tail (Guguy 1970), toe-nail clipping (Frye 1991) or collecting blood from the major veins and arteries (Maxwell 1979) have been some of the other proposals. Each of them has at least one disadvantage, for example, intricate dissection of veins/arteries is required (Avery and Vitt 1984). The procedure for obtaining blood samples from the ventral caudal vein as suggested by Galbraith (pers. comm.) and described in alligator snapping turtles (Powell and Knesel 1992) had been initially utilized in our procedure but we had to discard it as the amount of blood obtained was not enough for multiple analyses. Falling back on the oldest method of heart puncture by inserting a long needle laterally through the soft tissue between the plastron and the carapace, we found that the forelimb provides the safest and the shortest path to reach the heart avoiding drilling of the plastron. In addition, our technique does not require elaborate equipment and can be used easily in the field.

We have applied this technique on two turtles of the genus *Kachuga: K. tentoria* and *K. dhongoka.* These are primarily medium sized turtles with males ranging between 10-20 cm and females between 22.5-45 cm in carapace length. Presumbaly this technique can be applied to many other turtles of similar size.

Handling of turtles to keep them immobile is a skill of the field worker and no standard procedure can be described for it. However, the turtle has to be suspended in a manner that the head hangs freely downward and the forelimb remains unrestrained. The weight of the body forces the forelimb to stretch, but this may need some time. In this position the right forelimb can be stretched at an angle of 35° from the head. The skin joining the leg with the carapace is dabbed with 95% alcohol in order to sterilize the area.

A 5-9 cm long 22 guage hypodermic needle attached to a 5 ml syringe is inserted parallel to the stretched forelimb. The needle is gently inserted till it reaches the ventricle. The depth of needle penetration is often between 2.5-7.5 cm. Gentle suction is applied until blood spurts into the syringe and withdrawal pressure is then slowly increased, until the syringe is at its full suction capacity. The needle is then slowly pulled out, with full syringe suction still being applied. About 2-3 ml of blood is drawn per sample. No pressure is applied for the control of bleeding as no visible bleeding occurs in this procedure. However, germicidal powder is immediately sprinkled at the point of insertion of needle before marking and releasing the turtles.

Blood samples have successfully been collected from over 50 fresh water turtles and several of them have been utilized for repetitive blood lettings and maintained in captivity for over 4 months with no apparent ill-effects. For field sampling this procedure provides a safe; practical and simple technique for obtaining blood from turtles.

We thank Mr. Dayal Prashad Gupta and Mr. Akash Mathur for their help in collecting turtles.

May 31, 1994

RESHMA BATRA
SANT PRAKASH
Department of Zoology, Dayalbagh Educational Institute, Dayalbagh, Agra-282 005.

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22. CLUTCH SIZE IN SHAW'S WOLF SNAKE *LYCODON STRIATUS*

On the morning of 27 July, 1993, I bagged a 410 mm long Shaw's wolf snake *Lycodon striatus* from deciduous forests of Kamalnath Forest Block in Udaipur District. I kept the snake in a card board box of dimension 45 x 30 x 30 cm. On the morning of 29 July, 1993 I found one white, elliptical egg in the box which measured about 25 x 7 mm. Obviously it had been laid in the night of 28 July, 1993. After this, no more eggs were laid by the snake and I set it free on 5 August, 1993 in the locality of capture.

According to Daniel (1983, THE BOOK OF INDIAN REPTILE), 2 to 4 eggs are laid by Shaw's Wolf Snake.

August 31, 1994

SATISH KUMAR SHARMA
Range forest Officer, Aravalli Afforestation Programme,
Jhadol (F.), Distt. Udaipur (Raj.) 313 702.

23. LENGTH RECORD OF THE COMMON WOLF SNAKE (*LYCODON AULICUS*) FROM BHARUCH, GUJARAT

On February 4, 1993, we received a snake from Mr. R. Tiruvengadam, Officer-in-Charge, GNFC's Wildlife Complex, Bharuch.

It was a female common wolf snake, *Lycodon aulicus* (Linnaeus). It was collected from GNFC township, Bharuch, Dist. Bharuch. The snout to vent length was 81.0 cm, tail length 11.0 cm and total length of the specimen was 92.0 cm. Scales were supralabials 9, 4th and 5th touching the eye, midbody scales 17:17:15 rows, divided into ventrals 232 and caudals 51. Body colour was dark brown with 34 white bands which are laterally bifurcated and the belly white.

According to Whitaker (1978, COMMON INDIAN SNAKES: A FIELD GUIDE), the maximum length of the species was 80.0 cm and recently Karthikeyan (1993, *J. Bombay nat. Hist. Soc. 90*: 298-299) reported an even larger specimen that measured 82.0 cm from the Shevaroys. Hence our specimen is the largest known so far.

March 27, 1994

RAJU VYAS
Sayaji Baug Zoo,
Vadodara-390018, Gujarat, India.

B.H. PATEL
Dept. of Zoology,
Sir P.P. Institute of Science,
Bhavnagar-364002,
Gujarat, India.

24. AMPHIBIANS OF PHULWARI KI NAL WILDLIFE SANCTUARY

The Aravalli range is the principal mountain range of Rajasthan which runs diagonally across the state from north-east near Delhi and to south-west up to the plains of Gujarat for about 692 km. Within Rajasthan, it runs for about 550 km. from Khetri in the north-east to Khed-Brahma in the south-west. The Phulwari Ki Nal Wildlife Sanctuary is a small area, covering 511.4 sq. km and situated towards the south-west end of the Aravallis near Khed-Brahma in Udaipur district of Rajasthan.

Phulwari Ki Nal Wildlife Sanctuary falls in a semi-arid zone, with a rainfall of 600-800 mm per annum. The terrain is undulating with altitudinal variation from 600-900 m above MSL. The forests are of the northern tropical dry deciduous type. Major plant species of the area are *Dendrocalamus strictus, Boswellia serrata, Lannea coromandelica, Sterculia urens, Dalbergia latifolia, Wrightia tomentosa, W. tinctoria, Terminalia belerica, Flacourtia ramontchi, Anogeissus latifolia, Helicteres isora, Grewia tiliaefolia, Aegle marmelos, Soymida febrifuga, Celestrus paniculata, Zizyphus xylopara, Anangium salvifolium, Butea monosperma, Pterocarpus marsupium, Ougenia dalbergioides, Pongamia pinnata, Syzygium heyneanum, Emblica officinalis,* etc.

A list of amphibians recorded from Phulwari Ki Nal Wildlife Sanctuary is given below:

Family: RANIDAE

(1) **Rana cyanophlyctis:** Very common, seen in ditches mine-pits, nullahs, rivers, ponds, wells, forest nursery tanks, etc. During the rainy season, it can be seen on roads at nights. It is found round the year, except during the winter. The Kathodis, a local tribe, use these frogs as bait for fishing purpose.

(2) **Rana limnocharis:** Very common, seen in damp places with grassy cover. From September onwards, when water level of hill nullahs become low, these frogs

can be seen among boulders of streams. This frog is generally visible from July to October only.

(3) **Rana tigerina:** Common, locally called *dhedka* by the tribals, lives in ditches along the road side, hill streams and in the stagnant water of the paddy field bordering the sanctuary. It is visible in paddy fields at the time of sowing of paddy. When paddy becomes tall, it remains hidden under vegetative cover.

(4) **Tomopterna breviceps:** Very common, appears on the ground with the pre-monsoon showers, and retires for hibernation in winter. During earlier monsoon showers it can be seen in ditches, pits, etc., generally at night and before noon. After egg-laying, it becomes terrestrial like a toad. It falls in forest nursery-tanks during night and dozens can be seen swimming sluggishly in water. If water level is low in the tank due to vertical walls, they cannot escape (Sharma 1993). In their effort to climb rough walls, they injure the fingers and toes. Sometimes, a few are seen floating dead in water tanks.

During the rains, males of this species become vocal. Their calls can be heard all night till the morning.

From September onwards, one can come across. *T. breviceps* in large numbers while moving in dry nullahs. This frog goes into burrows when winter starts.

Family: Microhylidae

(5) **Microhyla ornata:** Uncommon, and terrestrial, lives in damp, covered hide-out. It leaves the ponds, ditches, etc. during the day and comes out only during the night for feeding and breeding. In cemented tanks, where escape is not possible, it can be seen climbing walls above the water level. This species remains visible during the monsoon period only.

(6) **Uperodon systoma:** Uncommon, becomes visible in monsoon only. Two males and one female were collected from a small cemented tank near Nalwa Wildlife Chowki. A pair was bagged on the periphery of the Sanctuary. The weight of the male was 14 g and that of the female 26 g. They were kept in a tank, where the female laid 1784 eggs in one night. After egg laying, the female was re-weighed and found to be 22 g. Males of this species are vocal and make loud calls in the early hours of the morning. Males call while swimming to and from their burrows. During the day frogs of this species vacate the pond. This species remains visible only during the monsoon rains.

Family: Bufonidae

(7) **Bufo melanostictus:** Common Seven species of amphibians contained in five genera belonging to three families have been recorded from Phulwari Ki Nal Wildlife Sanctuary. So far six species of amphibians are known from the region of Udaipur district, namely *Rana cyanophlyctis, R. limnocharis, R. tigerina, Tomopterna breviceps, Bufo melanostictus* and *B. andersoni* (Mansukhani and Murthy 1964). Two species are being recorded for the first time from Udaipur district, namely *Microhyla ornata* and *Uperodon systoma.*

I thank Mr. A.S. Champawat I.F.S., Dy. C.F., Aravalli Afforestation Project, Udaipur (Central) and Mr. J.S. Nathawat, Deputy Chief Wildlife Warden, Udaipur for providing facilities.

January 31, 1995

SATISH KUMAR SHARMA,
Range Forest Officer,
Aravalli Afforestation Programme,
Jhadol (F.), Dist. Udaipur (Raj.) 313 702.

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25. *LABEO MICROPTHALMUS* (DAY) (PISCES: CYPRINIDAE), A NEW RECORD FROM BIHAR, INDIA

Introduction

During the course of ichthyofaunal survey of the river Gandak at Balmikinagar, Bihar (27° N, 84° 15' E), a specimen of *Labeo* was collected along with other fishes, which, after examination was identified as *Labeo micropthalmus* (Day). The identification of this specimen has been confirmed by the Zoological Survey of India, Calcutta. A perusal of existing Indian literature on the ichthyofauna (Day 1878, 1889; Jayaram 1981, Jhingran 1956, Menon 1950, 1974; Munshi Datta and Srivastava 1988, McClelland 1839, Talwar and Jhingran 1991) reveal that *Labeo micropthalmus* (Day) has not been recorded earlier from Bihar. Hence the present collection and the distributional notes of this carp would be of interest in highlighting the extended range of its distribution in new areas not recorded earlier. The specimen captured by cast net was fixed in 3%, and later preserved in, 5% formaline solution.

DESCRIPTION

Labeo micropthalmus (Day)

English name — Murrie Labeo

Material examined: 2 specimens, 116-150 mm TL, from Balmikinagar, Gandak river, Collector: S.K. Mishra; 6 April 1993.

Diagnostic features: Diii 10; Aii 5; Pi 17; Vi 8;C 19

Length of head 6, depth of body 5.5, both in total length. Eye diameter 5 in head length, 2 in snout length and 2.25 in the interorbital width. Dorsal profile of body more convex than its ventral profile. Snout overhanging mouth, with an indistinct lateral lobe; lips continuous; no pores on snout; interrupted groove across lower jaw. Mouth inferior; a cartilagenous covering to inside lower jaw.

Barbels one pair, maxillary. Dorsal fin upper margin concave, its origin midway between snout tip and posterior base of anal fin, the height higher the depth of body.

Colour: In life, body silvery, darkest on the back; scales occasionally marked with red.

Zoogeographical distribution: Pakistan; and INDIA: Punjab, Himalayas, Murree and Kangra also Kashmir. This species is a noteworthy addition to the ichthyofauna of Bihar.

DISCUSSION

Labeo microthalmus (Day) attains a length of 25 cm and is of minor interest to fisheries. Menon (1974) considered this species to be a synonym of *Labeo dero* (Heckel) but there are several differences. *Labeo micropthalmus* (Day) can be distinguished from *Labeo dero* (Heckel) by the following key.

1. (a) Snout with an indistinct lateral lobe; pores on snout generally absent; dorsal fin higher than body depth .... *L. micropthalmus*
- (b) Snout without any lateral lobe, pores on snout generally present; dorsal fin equal to or shorter than body depth .... *L. dero*

February 3, 1995

SAFAL KUMAR MISHRA
Department of Zoology, T.P.V. College, Narkatiaganj, W. Champaran, Bihar.

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26. ADDITIONAL INFORMATION ON THE GREY MULLET *RHINOMUGIL CORSULA* (HAMILTON) (PISCES: MUGILIDAE) FROM WESTERN MAHARASHTRA

In 1981, Singh and Pradhan reported the occurrence of *Rhinomugil corsula* (Ham.) in parts of the river Bhima. However, they reported that this fish is absent from the rivers Mula and Mutha in Pune. During our extensive survey of the Mula-Mutha rivers carried out mainly between 1990 and 1993, it was found that the fish occurs at the Bund Garden, downstream from the confluence of Mula and Mutha. We observed at least 3-4 regular shoals, of about 8-10 fishes each, swimming in the shallow waters beneath the bund wall. It was easy to identify the fish with binoculars because of its peculiar swimming habits aptly described by Hora (1938).

The fish is very quick and alert and easily escapes cast nets. With considerable effort we could obtain a specimen from this area. The fish was subsequently identified using the key given by Jayaram (1981) and Talwar and Jhingran (1991). During monsoon floods, however, they are often captured in this area. Although present in Mula-Mutha, near their confluence, the fish is certainly not abundant. It is very rarely found in the upper stretches of the Mula river. However, as yet, we have not seen this fish in the Mutha river.

In addition to the above we have collected the species from Veer dam on river Nira, where it is abundant. It has also been collected from river Tapi near Bhusaval, by one of our students.

This forms probably the first report of its occurrence from river Tapi, North Maharashtra. The fish is also abundant at the Ujani dam on river Bhima (Pradhan and Singh 1984 and also our personal observations). Recently, Manakadan (1993) has reported its occurrence at the Tungabhadra-Krishna confluence in Andhra Pradesh.

Thus, it is clear that *R. corsula* is spreading in the Krishna river system. It is already reported by Menon and Jayaram (1977) from the Cauvery river system.

It thus appears that this Gangetic fish is fast spreading all over Peninsular India. It is, in all probability due to accidental introduction alongwith the seeds of cultivated carps.

In addition to the above information on the sighting of *R. corsula* (Ham.), we would also like to mention here that the fish is locally known in Pune as *Var-doli* (meaning eyes-above) and among fisherfolk of Veer dam, as *Bhuit*.

ACKNOWLEDGEMENT

We sincerely appreciate and acknowledge the help rendered by Dr. K.C. Jayaram in identifying and confirming many fishes, including this one.

February 3, 1995

H.V. GHATE
G.K. WAGH
Post-Graduate Research Centre,
Department of Zoology,
Modern College, Pune-411 005.

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27. EXTENSION OF RANGE OF *DANIO (BRACHYDANIO) RERIO* HAMILTON-BUCHANAN

Danio (Brachydanio) rerio Hamilton-Buchanan is reported to be distributed from eastern part of West Bengal to Krishna river system, Andhra Pradesh and Tamil Nadu (Jhingran and Talwar 1991). Day (1875) considered this as *Danio rerio* and described its distribution from Bengal to Coromandel coast and Masulipatam (Masulipatanam). Jayaram (1981) described it under subgenus *Brachydanio*.

While conducting a survey of fishes to the Wyanad region of Nilgiri Biosphere Reserve, 9 specimens of *Danio (Brachydanio) rerio* were collected from two different rivulets passing through Kuruva and Chekadi joining Kabani. These rivulets are seasonal and flow through teak plantations and paddy fields.

All the specimens are kept in the Kerala Forest Research Institute, Peechi, Thrissur, Kerala.

ACKNOWLEDGEMENTS

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February 4, 1995

C.P. SHAJI
P.S. EASA
Division of Wildlife Biology, Kerala Forest Research Inst.,
Peechi 680 653, Kerala.

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JHINGRAN, A.G. & P.K. TALWAR, (1991): Inland Fishes of India and Adjacent countries. Oxford and IBH Publishing Co., New Delhi.

28. A STUDY ON BUTTERFLY POPULATIONS AT GUINDY NATIONAL PARK, MADRAS

(*With a text-figure*)

INTRODUCTION

Many species of animals are known to show seasonal fluctuations in their numbers and densities (Begon and Mortimer 1986, Young 1982, Davidson and Andrewartha 1948). This makes some species common during some parts of the year and less common at other times. These seasonal variations in population sizes might be due to several natural factors like their breeding cycles, seasonal movements across habitats, availability of food, etc. (Erlich 1986). Understanding such fluctuations in animal populations can help in their management and conservation as was shown in case of the whaling industry (May 1980).

STUDY SITE

Guindy National park is a 2.7 Sq. Km dry evergreen scrub forest in the heart of Madras city. The vegetation of the park, based on the major species composition can be classified into five kinds (Rajasekhar 1992a). However in the present study, only two basic types, the dense woodland covering about one third the park area and the second, open scrub forest habitat covering most of the park have been recognised. The major fauna of the park include the Spotted Deer (*Axis axis*), Blackbuck (*Antilope cervicapra*), Jackals (*Canis aureus*), a few other small mammals and reptiles. Over 120 species of birds have been recorded over the past two years in the park (Rajasekhar 1992b).

METHODS

Regular marked trails in both, the dense woodland and in the open scrub habitat were traversed in the mornings and evenings, once every month of the year 1991. All butterflies sighted were identified and recorded. The identifications were based on direct visual observations and no captures were made. Identifications were confirmed from Satyamurti's Catalogue of the butterflies at the Madras Museum and from captures made in other unprotected green pockets in the city.

The year was divided into four seasons based on general observations on the climate and all butterfly sightings over each of the three months were pooled together for analysis. March to May was the peak dry season with most of the vegetation dry and defoliated. The first wet season from June to August receives scanty rainfall through the South West monsoon. The next three months from September to November were the second wet season and most of the year rainfall comes now from the North East monsoon. The post monsoon season from December to February are relatively cooler months of the year with some occasional showers.

Since sampling effort in the four seasons was unequal, only relative estimates of the abundance were possible. Data on the Emigrants (*Catopsilia* sp.) was discarded from analyses due to discrepancies in identification. Based on the relative abundance estimates, the butterflies were classified as follows,

Abundant: > 30%; Very Common: 20% — 30%; Common: 10% — 20%; Frequent: 5% — 10%; Occasional: 1% — 5%; Rare: < 1%.

The mean relative abundance values of all the counts in the two habitats were calculated for the different species in the four seasons. Differences between the means across the habitats were tested to determine any habitat preference by the butterflies.

OBSERVATIONS

The main observations have been detailed in Table 1, and in Figure 1. As is apparent from the figure and table many species of butterflies showed distinct seasonal fluctuations and in fact a few of them (6) were completely absent in some parts of the year. Though some species showed preference of habitats, none of them were completely restricted to any one habitat type. The number

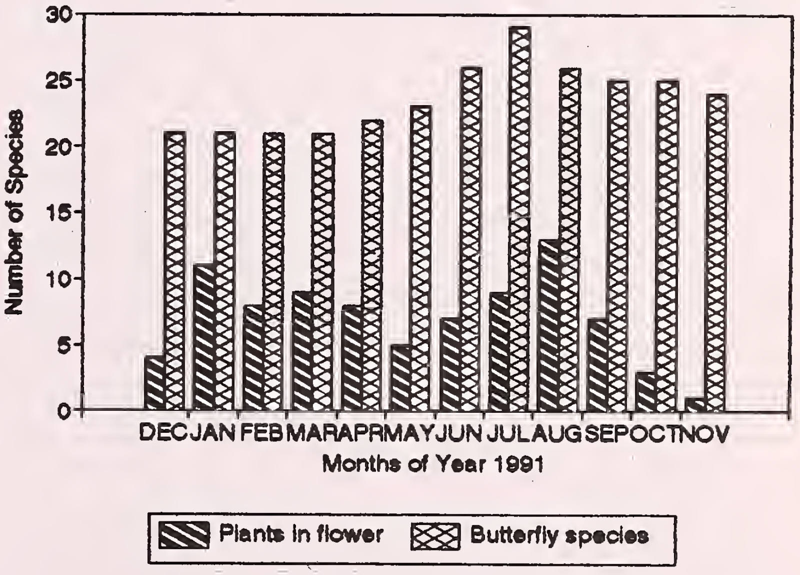

Fig. 1. Number of butterfly species and plants in flower seen each month.

TABLE I

STATUS AND DISTRIBUTION OF BUTTERFLY SPECIES THROUGH THE FOUR SEASONS

Sl. No.	Species	Dec. Jan. Feb. Post monsoon	Mar. Apr. May Dry season	Jun. Jul. Aug. I wet season	Sep. Oct. Nov. II wet season
	PAPILIONIDAE				
1.	*Pachliopta hector*	Frequent *	Occasional *	Occasional $	Occasional $
2.	*P. aristolochiae*	Fequent *	Occasional	Occasional $	Rare
3.	*Papilio polytes*	Occasional *	Common *	Common $	Fequent $
4.	*Papilio demoleus*	Absent	Occasional	Common $	Frequent $
5.	*Pathysa nomius*	Absent	Absent	1 sighting	Absent
6.	*Graphium sarpedo*	Rare	Rare	Rare	Rare
	PIERIDAE				
7.	*Leptosia nina*	Occasional	Occasional	Rare	Rare
8.	*Delias eucharis*	Absent	Absent	Absent	Rare
9.	*Cepora nerissa*	Frequent	V. Common	Frequent $	Occasional
10.	*Colotis danae*	Absent	Absent	Rare	Absent
11.	*Ixias marianne*	Absent	Absent	Rare	Absent
12.	*I. pyrene*	Occasional	V. Common	Frequent *	Occasional *
13.	*Pareronia valeria*	Occasional *	Frequent	Rare *	Occasional
14.	*Catopsilia pomona*	!	!	!	!
15.	*C. crocale*	!	!	!	!
16.	*C. pyranthe*	!	!	!	!
17.	*Eurema blanda*	Common $	Frequent	Frequent *	Frequent $
18.	*E. hecabe*	@	@	@	@
	DANAIDAE				
19.	*Danaus genutia*	Occasional	Rare	Rare	Rare
20.	*D. chrysippus*	Occasional *	Frequent *	Rare	Occasional
21.	*Tirumala limniace*	Frequent $	Occasional	Frequent *	Occasional *
22.	*Parantica aglea*	@	@	@	@
23.	*Euploea core*	V. Common	Common *	Abundant *	Abuntant
	SATYRIDAE				
24.	*Mycalesis perseus*	!	!	!	!
25.	*Melantis leda*	!	!	!	!
	NYMPHALIDAE				
26.	*Neptis hylas*				Rare
27.	*Hypolimnas bolina*	Rare	Rare	Rare	Rare
28.	*H. misippus*	Rare	Rare	Rare	Rare
29.	*Junonia hierta*	Rare	Rare	Rare	Rare
30.	*J. orithya*	Rare	Occasional	Rare $	Occasional
31.	*J. lemonias*	Rare	Rare	Rare	Rare
32.	*J. alamana*	Absent	Absent	Rare	Rare
33.	*Precis iphita*	!	!	!	!
34.	*Vanessa cardui*			1 sighting	
35.	*Phalanta phalanta*	Frequent $	Occasional	Occasional $	Frequent $
36.	*Ariadne ariadne*	Rare	Rare	Rare	Occasional
37.	*Acraea terpsicore*	Common $	Frequent	Occasional $	Common $

@ Species of this genera indistinguishable in the field.

! Inconsistent data due to low detectability of species in the field.

Relative Abundance	Status	Habitat preference	Habitat
< 1%	Rare	*	Dense
1% — 5%	Occasional	$	Open scrub forest
5% — 10%	Frequent		
10% — 20%	V. Common		
20% — 30%	V .Common		
> 30%	Abundant		

of species seen every month varied between 21 to 29. The first wet season from June to August was perhaps the richest with as many as 29 species recorded in July alone. On the whole about 37 species of butterflies were recorded over the entire year. This excludes members of the families Lycaenidae and Hesperidae. However a few Lycaenids and Hesperids were identified from just visual observations in the field which are listed below.

The Common Pierrot (*Castalius rosimon*), The Southern Grass Jewel (*Zizeeria trochilus*), The Common Cerulean (*Jamides celeus*), The Indian Redflash (*Rapala melampus*) and the Indian Skipper (*Syrichtus galba*).

The Common Crow (*Euploea core*) was perhaps the most abundant species in the park throughout the year, while there were several species of butterflies that were seen just once over the entire year. About 40% of the species prefer the dense vegetation in the dry season while only 16% are relatively more abundant there in the wet season. On the other hand only 7% of the species were significantly more abundant, i.e. preferred the scrub vegetation in the dry season but in the wet season 50% of the species preferred the scrub habitat.

The number of butterfly species to the number of flowering plant species showed poor correlation (r= 0.07) over the 12 months of the year. However, data over the months from April to July gave a higher correlation (r=0.6), as can be seen in Fig. 1. Several species were also seen to breed in the park. The Common Emigrant (*Catopsilia crocale*) was seen laying eggs on young leaves of *Cassia* sp. in late May and early June. The Gull (*Cepora nerissa*) laid eggs on *Carissa spinarum*, a common scrub species of the park. The common species of the dense understorey vegetation, *Glycosmis cochinchinensis* was the host plant of the Mormon (*Papilio polytes*).

DISCUSSIONS

Seasonal variations in the abundances of butterflies seem to be following the general trends in the vegetation. The first wet season from June to August which immediately follows the dry season brings many species of plants and trees into new flush and many species of the scrub set flower during this period (Rajasekhar 1992a). Some of the species flowering now are *Albizia lebbeck, Guazuama tomentosa, Syzigium cumini, Randia* sp., *Carissa sp., Cassia sp., Acacia leucophloea, Clausena dentata* and *Casealpinia coriera*. The last one, *Caesalpinia* sp. attracts butterflies in the hundreds, the Common Crow and the Blue Tiger being the most common visitors. However with the drying up of the vegetation in summer, most species retreat to the dense vegetation where there are some flowering species like *Acacia planifrons, Atlantia monophylla, Azadirachta indica*, etc. The only species that is common in the scrub even in the summer is the Gull (*Cepora nerissa*), which is perhaps active in the early hours of the day when the vegetation is moist in the dew. Of course, this does not mean that the other species are not seen in the scrub at all, but just that they are relatively more abundant in the dense habitat. More over since only relative estimates have been made, it is important to note that a species can become less common in one season even if its numbers have not significantly reduced, but due to an increase in abundance of some other species.

The absence of the common host plants of many of these butterflies in the park, like the host plant of the Common Tiger (*Danaus chrysippus*), *Calotropis gigantea* may have something to do with their abundances. Other host plants like *Passiflora* sp., *Nerium* sp., *Aristolochia* sp., *Polyalthia* sp., etc. are either absent or too few in numbers in the park. However since these species of plants are quite common in other parks and gardens in the city, many of the butterflies perhaps migrate locally to breed elsewhere, on these plants (Rajasekhar 1991). Perhaps this is why areas in Madras with more modified vegetation like the MCC campus have greater species richness (Dayanandan *et al.* 1978).

The absence of some species of butterflies like the Common Lime (*Papilio demoleus*) in some parts of the year can only be explained by such local migrations (Wynter-Blyth 1957). The other rarer species are perhaps occasional-stragglers like the Painted Lady which is known to undertake long migrations (Torben 1987), might have strayed into the park accidentally.

A more intensive study monitoring the absolute abundances of the butterfly species for consecutive years could give more insight to the butterfly population dynamics at the Guindy National Park. This study has established the presence of some sort of relationship between the abundance of butterflies and the vegetation characteristics. Not surprising that butterflies inspite of fitting few ecological niches, are good indicators of environmental changes (Daniels 1991). This is important to the management of the park considering that some of the species that occur here are Schedule I species.

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B. RAJASEKHAR
Department of Zoology, Loyola College, Madras.
Present Address: *Centre for Ecological Sciences, Indian Institute of Sciences, Bangalore 560 012.*

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29. COMMENTS ON THE VARIATIONS IN *JUNONIA ORITHYA* COMPLEX (LEPIDOPTERA: NYMPHALIDAE)

(*With two text-figures*)

INTRODUCTION

According to Wynter-Blyth (1957) and Eliot (1992), the species referable to the genus *Junonia* Hubner are very susceptible to seasonal variations and in most part of their range, they occur in both wet and dry season forms. One of the species, *J. orithya* though is otherwise well known and unmistakable sorely needed revision (D'Abrera 1985). During the course of the present studies, some representative populations of the species, collected from different localities in North-West India have been examined to record variations. Besides updating the description of the species by recording some additional variations, comments have also been made on its male genitalia.

OBSERVATIONS

Some of the already known and presently observed variations of the species *J. orithya* are given in Table 1.

Owing to the variations within population of the individuals collected in the same or different seasons/ time of the year, we dissected as many as 16 males and 10 females of variable individuals from different localities. This was intended to confirm if all these individuals belong to the same species. The critical examination of the genitalia shows that one of the male specimens collected from Bajoura (Kulu, H.P. 1105 m) not only differs from the rest of the individuals of the species *J. orithya* collected from different localities but also from the closely allied individuals collected from the same locality on the same day at the same time. In the male genitalia of the Bajoura specimen (Fig. 1), the valvae (clasping organs) are relatively more strongly sclerotised. The cucullus has two well defined spines (compared to four in others), the costal margin is deeply incurved and the arrangement of the setae on the saccular margin is also different from *J. orithya* (Fig. 2). Besides, the transtilla of the Bajoura specimen is heavily setosed. Out of thirty six males, this is the only specimen in which the black ocellus in interspace 5 on the upperside of hindwing is completely ringed with orange and black.

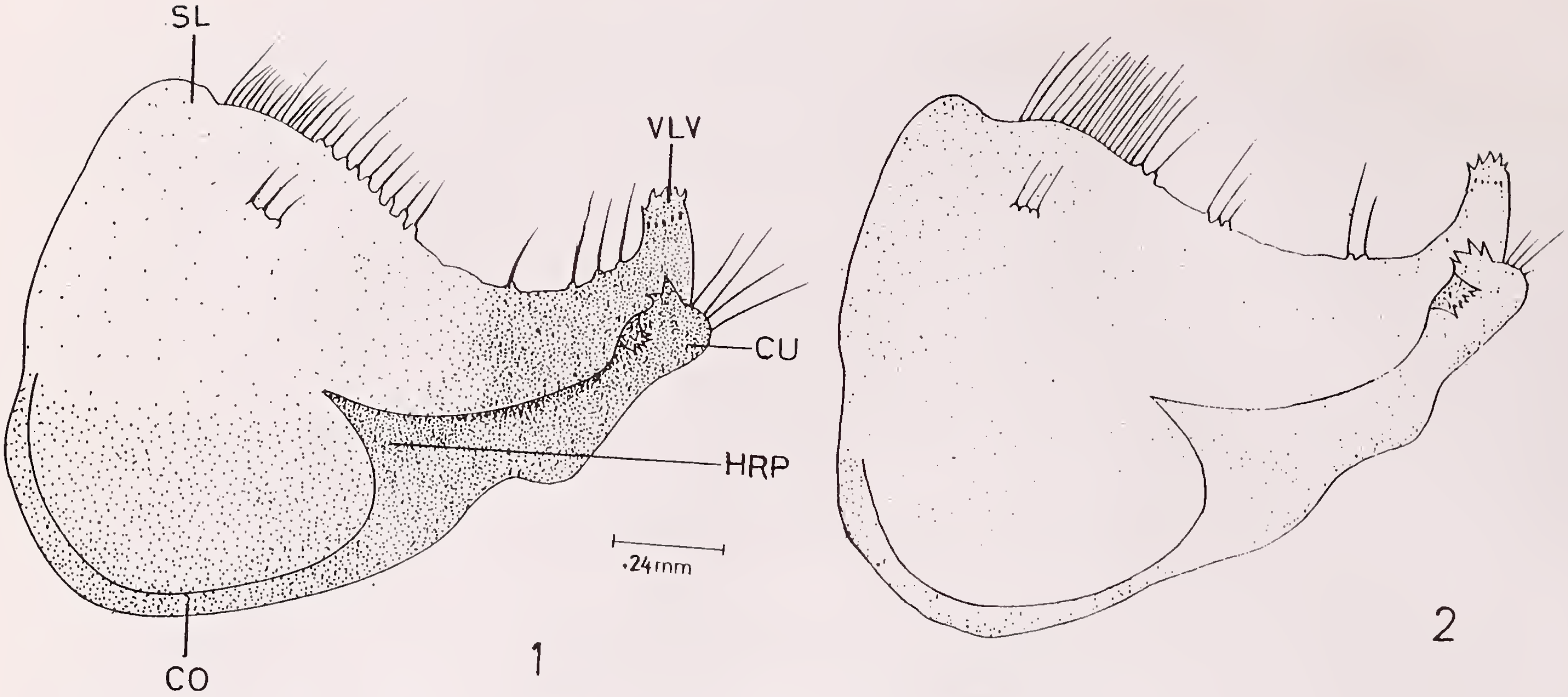
According to D'Abrera (1984), *orithya* is represented by a subspecies *ocyale* Hubner with its distribution extending from India to Southern Burma. The naming of one of the sympatric populations at Bajoura (Kulu, H.P.) as a different subspecies is thus taxonomically not possible. However, inspite of all above mentioned variations, the lone specimen is not being named as a new species at the moment. The present study, however, confirms the view of D'Abrera (loc.cit.) that *orithya* is in need of revision. Further, it should be described under *Junonia* and not under *Precis* as has been done by Varshney (1990). The latter genus occurs only in Africa and the two genera are quite different from one another (Eliot 1992).

Material Examined: HIMACHAL PRADESH: 1 male, 2 females, Rajgarh, 27. V.92; 1 male, Chambaghat, 28.V.92; 3 males, Nauni, 25.V.92; 1 male, Mcleodganj, 28.VI.92; 2 males, 3 females, Bhagsu Nag, 30.VI.92; 1 female,

Table I

VARIATIONS IN *Junonia orithya* LINNAEUS

S. No.	Taxonomic character	Earlier accounts (Bingham 1905, Wynter-Blyth 1957)	Present additional observations
1.	Forewing (upperside)	i) More than half of the base velvety-black 27 males, 5 females.	i) Dull fuliginous; 9 males, 21 females.
		ii) a. Cell area with two short transverse orange bars; 2 males, 5 females. b. Cell area without any bar; 10 males, 7 females.	ii) a. Cell area with one orange bar; 5 males, 5 females. b. Cell area with one blue bar; 12 males, 9 females. c. Cell area with two blue bars; 7 males.
		iii) Blue patch above the tornus; 30 males, 20 females.	iii) Brown patch above the tornus; 6 males, 6 females.
		iv) Large discal ocellus in interspace 2, generally obscure or is prominently ringed with orange yellow.	iv) a. Not so but large discal ocellus in interspace 2 is almost always present; 36 males, 26 females. b. Jet-black ocellus; 13 males. c. Half oranged ringed; 23 males. d. Prominently ringed with orange yellow; 26 females.
		v) A small black, orange ringed ocellus in interspace 5; 26 females.	v) a. Small black, orange ringed ocellus in interspace 5 is not seen in any male as mentioned by Bingham (1905). b. Black ocellus in interspace 5, ringed with white; 15 males. c. Half orange ringed; 21 males.
2.	Hindwing (upperside)	i) Velvety-black with blue shade towards base; 27 males, 5 females.	i) Dull fuliginous; 9 males. 21 males.
		ii) A post-discal black, white centred, orange and ringed black ocellus in interspace 2.	ii) Not seen in any specimen but the post-distal blue ocellus in interspce 2 is ringed with orange and black; 36 males, 26 females.
		iii) A round minutely white centred velvety-black spot (sometimes entirely absent) in interspace 5.	iii) a. It is present in both sexes as observed presently. b. The ocellus in interspace 5 is jet black; 16 males. c. Black ocellus with half orange ringed; 19 males. d. Black ocellus completely ringed with orange and black, one male, (Bajoura: Kulu, H.P. 1005 m)



Figs. 1, 2: Valvae of *Junonia orithya*. (Fig. 1, Bajoura specimen.)
Abbreviations: CO, Costa; CU, Cucullus; HRP, Harpe; SL, Sacculus; VLV, Valvulla.

Mahog, 14.VI.92; 1 male, Karaian, 15.VI.91; 1 male, Paonta Sahib, 1.XI.91, 1 female, 16.V.93; 4 males Bajoura, 28. vii. 92. UTTAR PRADESH: 1 female, Ranikhet, 28.IV.92; 1 female, Aglar valley, 4. VI.92; 1 female, Vikas nagar, 19.VI.92; 1 male, Mussoorie, 3.VI.92. PUNJAB: 6 males, 1 female, Patiala, 20.III.92; 1 female, 8.IV.92; 2 females, 18.IX.91; 1 female, 3.X.91; 1 female, 11.XI.91; 1 female, 10.IV.91; 6 males, 1 female, 4.V.93; 1 male, Sirhind, 29.III.91; 3 males, 4 females, Ludhiana, 11.IV.91; 1 male, 8.IV.91; 1 male, Govindgarh, 13.IV.91; 1 male, 1 female, Anandpur Sahib, 27.IV.91; 1 female Dhuri, 10.IV.91; 1 male, 1 female, Talwara, 30.V.91; 1 female, Nabha, 20.IX.91; 1 female, Ropar, 28.XI.91.

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H.S. ROSE
NARENDER SHARMA
Department of Zoology,
Punjabi University,
Patiala-147 002, India.

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30. EFFECT OF TEMPERATURE ON HATCHING AND LARVAL DURATION IN *SEPSIS NITENS* (SEPSIDAE: DIPTERA)

INTRODUCTION

The bionomics of Sepsidae has not received the attention it deserves from medical entomologists, although they are important from veterinary and medical entomological view point. In India very little has been done on the bionomics and larval development of Sepsidae.

Temperature and humidity are known to affect the behaviour of many insects in nature and under laboratory conditions (Dakshinamurty 1948). I studied the population structure of Sepsidae of Aligarh District and also tested their colour preference and effect of pesticides on these flies (Modassir 1993). In the present communication an attempt has been made to study the hatching, larval and pupal stages of *Sepsis nitens,* reared under laboratory conditions. The effect of temperature on the development of flies was also studied.

Materials and Methods

A laboratory colony of *Sepsis nitens* was developed by collecting adults from the field and keeping them in glass cages of 30 cm x 30 cm size. The females readily oviposited in the dung masses, kept in petri dishes in each cage and the larvae satisfactorily developed on buffalo dung. The same medium was used for hatching and development of larvae under laboratory conditions in the present study.

Results

The eggs of *Sepsis nitens* are laid intermittently in batches of 2 to 30. They are generally laid around the periphery of the dung mass and bear flagella-like appendage which projects from the surface of the dung. The eggs are oval in shape measuring 0.415 mm in length and 0.128 mm in width. The colour is creamy white. the flagella is nearly three to four times as long as the main body of the egg and may have respiratory function.

Temperature limits of eggs of *Sepsis nitens*: Observations were made to find the ovipositional behaviour and the hatching of eggs at temperature 10°, 15°, 20°, 26°, 32°, and 40°C (Table 1). Eggs did not hatch at 10°C in any of the experimental chambers. However, at 15°C the eggs hatched out in 12.5 hours and at 20°C in 12.3 hours. The incubation period was found to be 12 hours at a temperature ranging between 26° and 32 °C, and decreased further to 10 hours at 40°C. The moisture content of the dung, however, got reduced at 40°C, resulting in larval mortality just after hatching.

Larval development: Development of larvae was observed by keeping them under controlled temperature. The first instar larva was creamy white in colour, measuring 2.2 to 2.57 mm in size. The body is apparently twelve segmented and the cephalic and anal segments were clear. The cephalic segment was short and conical and armed with a pair of strong mouth hooks. The two posterior spiracles had a prominent anal protuberance. The first instar lasts for 2.4 to 2.8 days at a temperature of 28° to 30°C and 65 ± 5% relative humidity.

The creamish colour of second instar larva changes to brown in about six to eight hours. It measures 3.37 to 3.70 mm in size. The dorsal sensory papillae become prominent. The tubercular anterior spiracle becomes prominent.The duration of the second instar varies from 1.8 to 2.0 days at a temperature of 28° to 30°C and relative humidity of 65 ± 5%.

Table 1

THE DEVELOPMENT OF PRE-ADULT STAGES OF *Sepsis nitens* AT DIFFERENT TEMPERATURE

Temperature (°C)	Duration in days Incubation period	Larval period	Pupal period	Total duration in days
10.0	—	—	—	—
15.0	0.52	10.6	7.2	18.32
20.0	0.51	8.5	6.2	15.21
26.0	0.50	7.5	4.0	12.00
32.0	0.50	8.3	3.5	12.30
40.0	0.42	7.2	2.4	10.02

The second instar larv moults to third instar after about 4 days. the third instar larva measures 5.3 mm in size. Morphological features of the larva became prominent at this stage. Dorsal and ventral sensory plates are present with papillae at the terminal. The third instar larva shows characteristic jumping movements by fixing its mouth hooks into the posterior notches.

Effect of temperature on larval development: The effect of temperature was observed on the larvae of *S. nitens* by keeping them in petri dishes with dung at 10°, 15°, 20°, 26°, 32° and 40°C constant temperature. The larvae were obtained from the laboratory colony. No change in larval development could be observed at 10°C. At 15°C total larval duration lasted for 10.6 days while at 20°, 26° and 32°C the larval duration was reduced to 8.5, 7.5 and 8.3 days, respectively. At 40°C the dung dried up within a few hours and no development in the larvae could be noticed. On the contrary, there was mortality of larvae at 40°C due to the dryness of the dung mass.

Pupa: The pupae were somewhat elongated, nearly 4.0 mm in length and 1.0 mm in width. Both ends were pointed and a ventral pair of tubercles was present at the base of the posterior spiracular stalks. The pupae were at first light brown in colour but changed to dark brown in about 24 hours. The pupal period was found to be 3.5 to 4 days at a temperature of 26° to 32°C and 65 ± 5% relative humidity.

The relation between temperature and pre-adult stages of *S. nitens* was derived by the simple regression equation Y = a + bX where Y is duration of development in days, X is temperature and *a* and *b* are constant to be determined by least square.

In this way a linear relationship was obtained with regression equation $Y = 28.05 + 0.55X$. This linear relationship would become distinctly curvilinear if the extremes of temperature are also considered (Andrewartha and Birch 1954).

The effect of temperature on developmental stages is given in Table 1. As the temperature increased the total duration of pre-adult stage decreased, thus showing an inverse relation. The ideal range of temperature was between 15° and 26°C for larval and pupal development.

DISCUSSION

The development and activity in many insects increase in proportion with the suitability of climatic conditions particularly in the tropics (Dakshinamurty 1948). Under laboratory conditions the success of the experiment depends on the culture medium and development of the larvae. *Sepsis nitens* lays its eggs in dung masses which hatch out within days in the laboratory. The eggs are similar to those of *S. lateralis*, described by Hafez (1947). The larval features of *S. nitens* are similar to those of European and American Sepsidae (Henning 1952, Wharton and Roeger 1977).

The present series of observations suggested that the incubation period could be greatly dependent on temperature conditions and is prolonged at lower temperatures. Therefore the environmental conditions may be important for the breeding and growth of sepsids in nature.

The humidity is also important in larval development. For sepsids the moist dung mass kept at temperatures of 20° to 28°C was ideal for development. The combined effect of temperature and humidity can be profound on the larval development. Hammer (1942) could not find larvae of sepsid flies during the winter months. The viability of eggs and the development of larvae is inversely related to temperature. Normal development would be obtained within the limits of favourable range of temperatures and humidity. The pupal period reduced with increasing temperature but at higher temperature there is a risk of death of larvae and pupae due to drying of the medium.

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YASMIN MODASSIR
Dempe College of Arts and Science,
Miramar, Panaji 403 001, Goa.

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31. RECORD OF THREE SPECIES OF *RHOMBOGNATHUS* (HALACARIDAE: ACARI) FROM INDIAN OCEAN REGION

(*With twentyfive text-figures*)

Species of the Subfamily Rhombognathinae are phytophagous in nature. All occur in photic zone of marine or brackish water and mainly occur in association with algae, though a few forms have also been reported from interstitial sands.

Rhombognathus apsteini Lohmann is known from Kerguelen Island of temperate Indian Ocean (Lohmann 1907 a, b; Bovee *et al.* 1973, Newell 1984). Rao and Ganapati 1968 reported *Rhombognathus* sp. from interstitial sands of Waltair coast.

Rhombognathus papuensis Bartsch, 1989

Many specimens were collected among different algae from Visakhapatnam coast, Cape Comorin coast, Kovalam coast, and Andaman and Nicobar Islands.

MALE: The idiosomal length of males ranges from 252 μ to 350 μ.

All dorsal plates are separate (Fig 1). Paneled sculpture present medially and distally on AD, anteriorly and posteriorly on OC, and medially and laterally on PD. One pair of setae are present medially and one pair of gland pores laterally above the level of insertion of leg I on AD. OC with two antero-lateral corneae and two lateral glandular pores. OC is quadrate in outline and with two setae (one near the corneal zone and one posteriorly). PD becomes narrow anteriorly. PD with one pair of setae and two costae made up of porose panels.

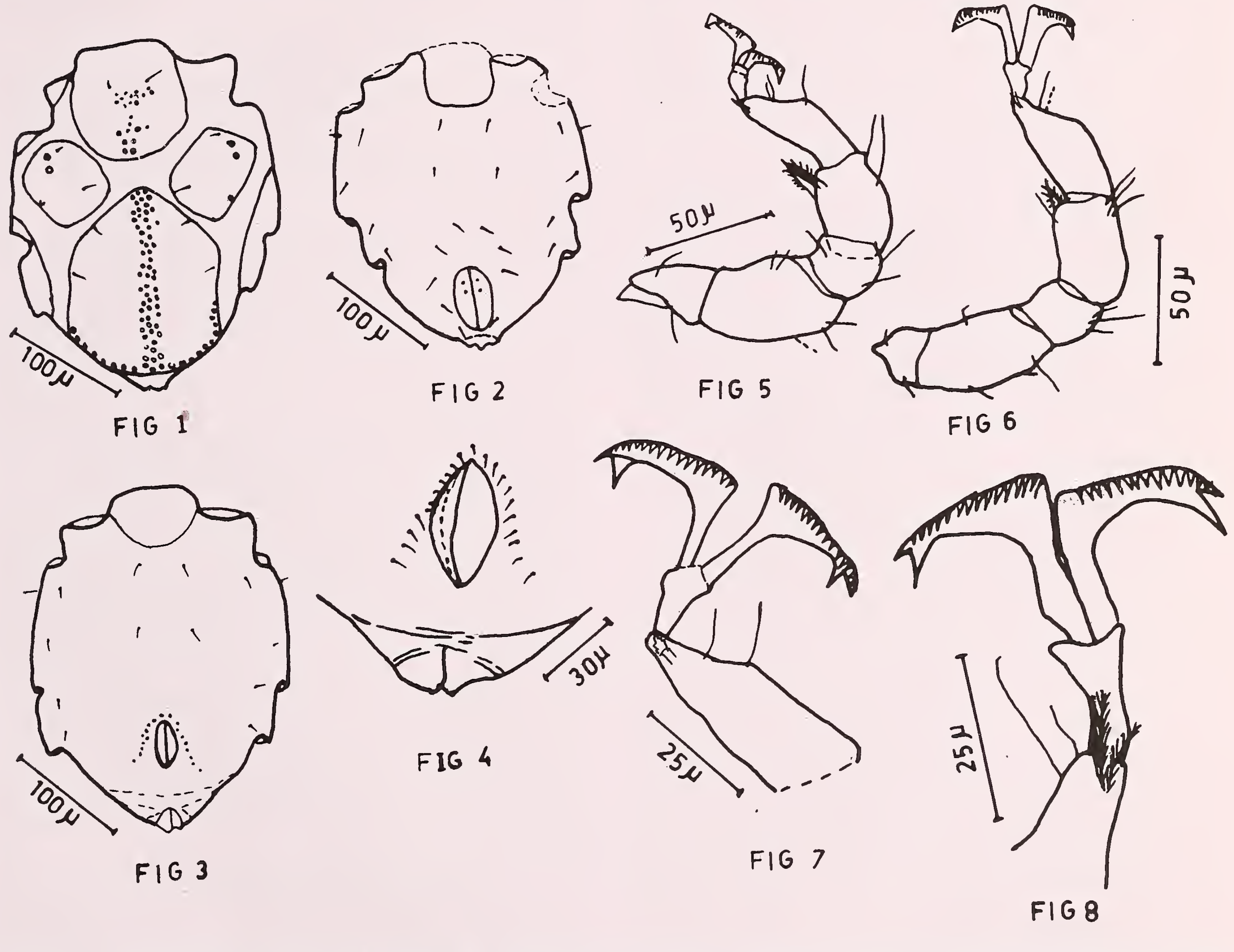
All ventral plates are fused (Fig. 3).

AE area bears Aes I, Aes IIv and Aes II lat with which one adjunctive seta is associated. PE area bears Pes IIIv, Pes III lat, Pes IV plus one adjunctive seta associated with Pes III lat. 11-13 pairs of plumose perigenital setae including one isolated basal seta are arranged in two discrete rows on each side of GO. Two pairs of subgenital setae are present (Fig. 4).

Telefemora III and IV devoid of any ventral setae. Patella I with five setae; all setae are smooth without any pectination or spiny nature. Tibiae I and IV with five setae, of which two are pectinate.

Tarsus I with 3 dorsal long setae, 1 solenidion, 1 profamulus and 4 PAS (2 doublets eupathidia) (Fig. 5). Tarsus II is similar to the former except for the absence of profamulus (Fig. 6). Tarsus III with 3 dorsal fossary setae, 1 basidorsal seta and 2 PAS Tarsus IV with 3 dorsal fossary setae and 2 PAS (two bristle-like setae) (Fig. 8).

All the legs bear carpite on tarsi and are devoid of a



Figs. 1-8. *Rhombognathus papuensis* Bartsch.: Fig. 1. Idiosoma-dorsal; Fig. 2. Idiosoma-ventral of female; Fig. 3. Idiosoma-ventral of male; Fig. 4. Genital area of male; Fig. 5. Basifemur to tarsus of Leg I; Fig. 6. Basifemur to tarsus of Leg II; Fig 7. tarsus IV of female; Fig. 8. Tarsus IV of male.

median claw. Lateral claws bare of dorsal accessory process containing more than 17 tooth-like serrations.

FEMALE: (Fig.2) Idiosomal length of females ranges between 250 µ and 350 µ. The female resembles the male very closely except for tarsus IV and GA region. Tarsus IV bears 3 dorsal setae and 2 PAS (one scaliform and one slender) (Fig. 7). 5 pairs of perigenital setae and 2 pairs of subgenital setae are present. Ovipositor bears 10 internal setae (Fig. 14).

Deutonymph: The idiosoma of a deutonymph is 157 µ long and 118 µ wide. All dorsal plates are separate and smaller than those of adult (Fig. 9). AD with 1 pair of setae. Anal plate and genital plate not separate. Genital foramen is not formed and two pairs of genital acetabulae are present (Fig. 10). Four pairs of legs are present.

Tritonymph: The idiosoma of tritonymph measured 243 µ in length and 175 µ width. All dorsal plates are separate and smaller than those of adult but longer than those of deutonymph (Fig. 11). Anal plate and genital plate are separated by cuticular membranous area (Fig. 12). Genital foramen is not formed. Three pairs of genital acetabula are present (Fig. 13). Four pairs of legs are present.

Distribution: Papua Guinea Island, Pacific Ocean, Bay of Bengal, Arabian Sea, Indian Ocean.

Remarks: The present find records the species for the first time from the Indian Ocean besides its first occurrence away from the type-locality (Papua Guinea island — Pacific Ocean). The nymphal stages of this species are also recorded for the first time. Bartsch (1989) did not comment on the internal setation of the ovipositor in *Rhombognathus papuensis*. In the present study, the ovipositor is observed and found to bear ten internal setae.

Rhombognathus scutulatus Bratsch, 1983

Many males and females were collected among different algae from Visakhapatnam, Cape Comorin, Kovalam, Andaman and Nicobar Islands (Corvin's Cove and Mus Island).

MALE: The idiosomal length of males ranged between 250 µ and 300 µ. All dorsal plates are fused and sculptured (Fig. 15). The sculpture is distinctly delineated at the corneal zone recalling the location of OC. AD bears a pair of setae at the level of leg I. OC with two setae, two antero-lateral corneae and two glanudular pores, one pore is associated with the corneae and one located postero-laterally on OC area. Postero-dorsal area bears a pair of seta.

All ventral plates are completely fused. AE area with Aes I, Aes IIv, and Aes II lat near the margin bearing one adjunctive seta associated with pes III lat. Eleven plumose PGS including one single isolated barsilar seta are arranged in two discrete rows on either side of the genital opening. Two SGS are present on each of the two sclerites (Fig. 16).

Gnathosoma small and compact. Palp is 4-segemented Palpal patella and trochanter without any setae. Palpal telofemur with one seta and palpal tibiotarsus with three setae.

Telofemora III and IV devoid of any ventral setae. Tibiae I and IV with 5 setae of which 2 setae are pectinate. Tibiae II and III with 5 setae including one pectinate. Tarsus I with 3 dorsal long setae, 1 soleniding, 1 profamulus and 4 PAS (two eupathidia doublets) (Fig. 18), Chaetotaxy of tarsus II similar to tarsus I except for the absence of profamulus (Fig. 19). Tarsus III with 4 dorsal fossary setae, two PAS (one scaliform serrated and one smooth and slender). Tarsus IV with 3 dorsal fossary setae and 2 PAS (two bristle-like setae).

All the legs bear carpite on tarsi and are devoid of a median claw. Lateral claws bear a dorsal accessory process containing more than 17 tooth-like serrations.

FEMALE: The idisomal length of female ranges between 240 µ and 325 µ.

Female resembles the male in all features except for tarsus IV and GA region. In the case of female, tarsus IV bears 3 dorsal fossary setae and 2 PAS (one scaliform and one slender). GA with 5 PGS on either side of GO. Two SGS are present on GO (Fig. 17). Ovipositor bears 10 internal setae.

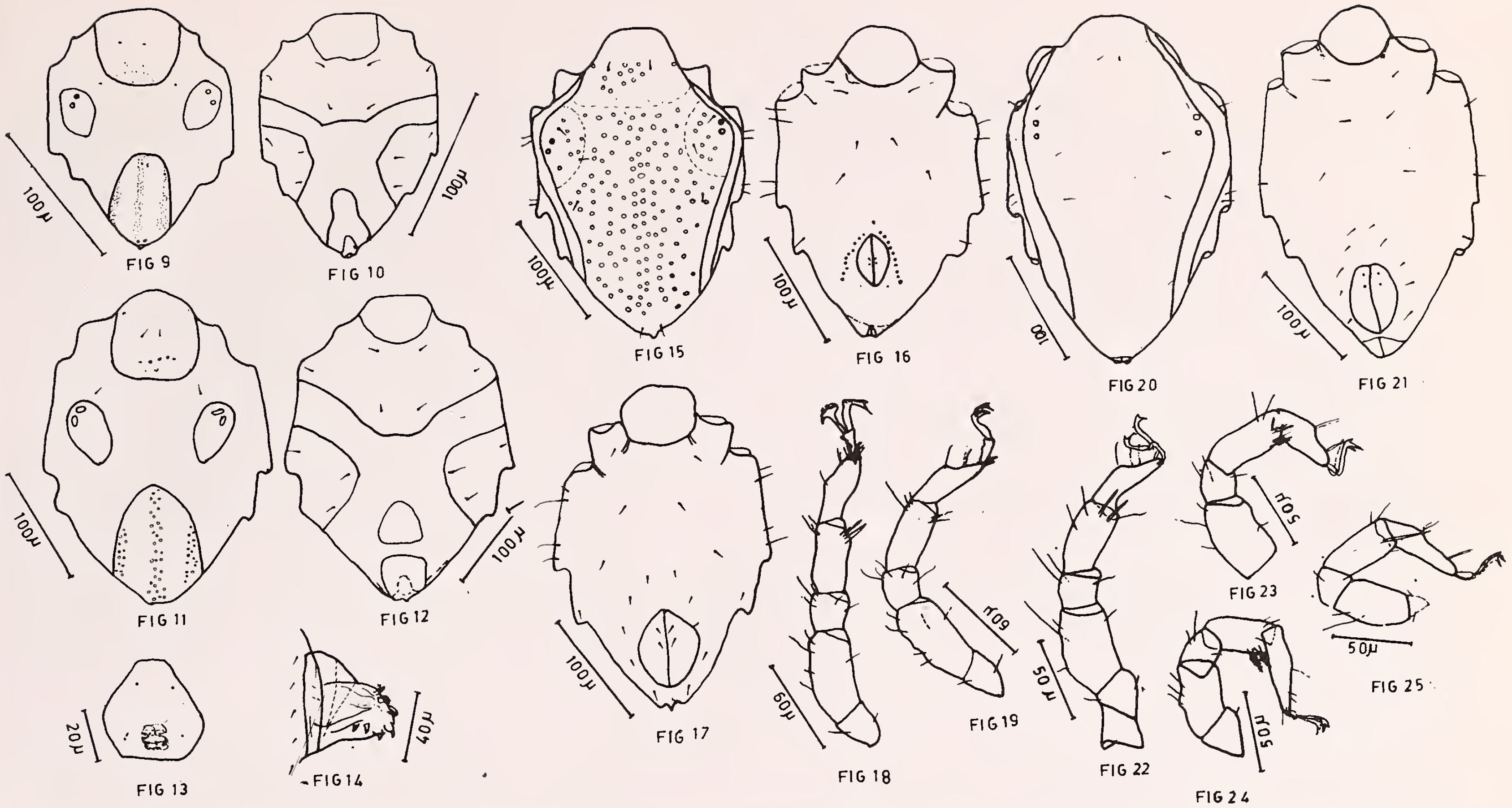
Distribution: Philippines. Bay of Bengal, Arabian Sea-Pacific Ocean. Indian Ocean-Present record.

Remarks: The ovipositor in the case of females was observed and is found to possess 10 internal setae confirming the assumption of Bartsch (1975) regarding the generic diagnostic value of the ovipositor setae present in all the species of genus *Rhombognathus*. The present find records the species for the first time from Indian Ocean besides its first occurrence away from the type-locality (Philippines — Pacific Ocean). The species is recorded here from Bay of Bengal, Arabian sea, Andaman and Nicobar Islands on a variety of algal substrates. Thus the species may be said to be widely distributed in the Indo-Pacific region.

Rhombognathus similis Bartsch, 1977

A single female was collected from the coralline algae *Halimeda oputina* from Mus Island (Nicobar Islands) — Bay of Bengal.

FEMALE: All dorsal plates are fused (Fig. 20) AD-area



Figs. 9-14. *Rhombognathus papuensis* Bartsch: Fig. 9. Idiosoma-dorsal of deutonymph; Fig. 10. Idiosoma-ventral of deutonymph; Fig. 11. Idiosoma-dorsal of tritonymph; Fig. 12. Idiosoma-ventral of tritonymph; Fig. 13. Genital plate of tritonymph; Fig. 14. Ovipositor showing internal setae.
Figs. 15-19. *Rhombognathus scutulatus* Bartsch.: Fig. 15. Idiosoma-dorsal of male; Fig. 16. Idiosoma-ventral of male; Fig. 17. Idiosoma-ventral of female; Fig. 18. Basifemur to tarsus of Leg I; Fig. 19. Basifemur to tarsus of Leg II.
Figs. 20-25. *Rhombognathus similis* Bartsch: Fig. 20. Idiosoma-dorsal of female; Fig. 21. Idiosoma-ventral of female; Fig. 22. Leg I; Fig. 23. Telo femur to tarsus of Leg II; Fig. 24. Basifemur to tarsus of Leg III; Fig. 25. Basifemur to tarsus of Leg IV.

with a pair of gland pores near the insertion of leg 1; ds1 on AD area below the level of ist leg insertion. OC area with two corneae. The ds_2 are present anterior to the corneae while ds_3 at the postero-ventral region of OC area. PD area with a pair of setae below the level of insertion of leg III.

All ventral plates are fused (Fig. 21). AE area bears Aes I, Aes IIv and Aes II lat on the margin. PE area bears Pes IIIv, Pes III lat with an adjunctive associated seta and Pes IV. Five PGS are present on each side of the GO. Two SGS are present on each sclerite.

Telofemorae: I and II with one ventral and three dorsal setae (Figs. 22, 23). Telofemora III and IV devoid of any ventral setae. Tibiae I and IV with 5 setae each (out of which two are bipectinate). Tibiae II and III with 5 setae each (our of which one is bipectinate). Tarsus I with 3 dorsal long setae, 1 solenidion, 1 profamule and 4 PAS (2 eupathidia doublets). Tarsus II similar to tarsus I except for the absence of proformules. Tarsus III with 4 dorsal fossary seta and 2 PAS (one scaliform dentatus and one slender) (Fig. 24). Tarsus IV with 3 dorsal fossary setae and 2 PAS (one scaliform and one slender) (Fig. 25).

All legs with two lateral claws provided with a dorsal accessory process bearing 5-6 minute teeth ventrally.

Distribution: Galapagos Island — Pacific Ocean. Bay of Bengal — Indian Ocean — Present record.

Remarks: The specimens closely agree with the description given by Bartsch (1977). The find also records the occurrence of *R. similis* for the first time away from its type-locality, extending its zoogeographical distribution into the Indian Ocean.

Acknowledgement

I wish to record my deep indebtedness to Dr. Ilse Bartch, Biologische Anstalt Helgoland, Hamburg, Germany for her assistance.

February 2, 1995

TAPAS CHATTERJEE
Dept. of Biology, Indian School of Learning,
(Indian School of Mines Annexe),
Dhanbad-826004, Bihar.

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32. OCCURRENCE OF THE CRAB *EUXANTHUS EXSCULPTUS* (HERBST) IN GUJARAT

(*With a text-figure*)

During the study of the diet of a coastal migratory wader, the Crab Plover *Dromas ardeola* in the Gulf of Kachchh, Gujarat state, one of us (TM) analyzed fragments of the bodies of various crabs in the birds' regurgitated pellets. To facilitate identification of these fragments, a collection of over 500 crabs from the area was made on the Rozi coast (22° 33' N, 70° 02' E), near the Jamnagar port between August 1987 and May 1988. Almost all of these crabs had been recorded earlier from the Gujarat coast by Chhapgar (*J. Bombay nat. Hist. Soc. 1957, 1958, 1961*). There was one exception, namely *Euxanthus exsculptus* (Herbst) (*E. melissa of* Alcock). The width of the carapace was 69 mm.

The crab can be identified by the fairly sharp, irregularly scalloped antero-lateral borders being prolonged beneath the orbit to the buccal cavern, and by the basal antennal joint jutting into the orbit, so that the antennal flagellum is inside the orbit. There is no denticle at the outer end of the orbit.

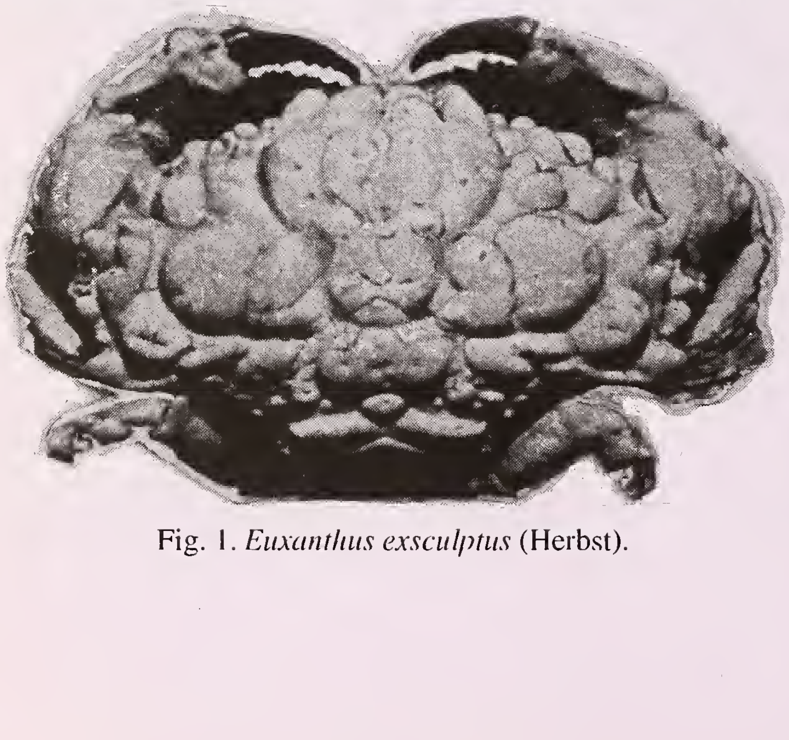

Fig. 1. *Euxanthus exsculptus* (Herbst).

The antero-lateral borders are cut into five teeth, with a tubercle between the fourth and fifth teeth. The lobules of the carapace are smooth. The chelipeds are equal in size and the fingers, with strongly toothed cutting edges, have their tips hollowed.

Alcock (1989), recorded this species from the Andaman Islands, Sri Lanka, Mergui and Samoa, while Serene subsequently found it in Tahiti. The present find, therefore, constitutes a first record of this species from the west coast of India.

ACKNOWLEDGEMENT

We are grateful to H.G. Ghosh, Assistant Zoologist at the Zoological Survey of India, Calcutta (ZSI) for comparing the crab with one of Alcock's specimens in the collections of the ZSI, and for his comments.

March 14, 1995

B.F. CHHAPGAR
Taraporevala Aquarium, Bombay-400 002.
TAEJ MUNDKUR[1]
Department of Biosciences, Saurashtra University, Rajkot 360 005, Gujarat.
[1]Present address: *Asian Wetland Bureau, Institute of Advanced Studies, Universiti Malaya, Lembah Pantai, 59100 Kuala Lumpur, Malaysia.*

33. FIELD INCIDENCE OF SNAIL ON KHARIF GROUNDNUT

The groundnut crop is attacked by more than 90 arthropod pests in the world (Amin 1988). Besides arthropod pests Adimani (1976); Puttaswamy *et al.* (1981) and Panchabhavi and Hullatti (1983) recorded a molluscan pest, the snail, *Cryptozona semirugata* (Beck) (Stylommatophora: Ariophantidae) as feeding on seedling of soyabean, groundnut seeds sown for germination and groundnut flowers along with many other cultivated crops. A new species of snail belonging to the same order has been observed for the first time in India feeding on groundnut flower.

During July to September 1989 the Kharif groundnut crop at Regional Research Station, Chiplima (Western Orissa) was infested by a minute snail, *Lamellaxis gracile* (Hotton) (Stylommatophora: Sublinidae) that fed on groundnut flowers. Preliminary investigation indicated a loss of 10 to 15 per cent flower/plant, which ultimately impaired pod formation.

ACKNOWLEDGEMENT

I thank Dr. Surya Rao, Zoological Survey of India, Calcutta for identification of the pest.

March 8, 1995

P.C. DASH
Regional Research Station,
Orissa University of Agriculture and Technology,
Chiplima-768 026, Sambalpur, Orissa.
Present address: *Department of Entomology,*
Orissa University of Agriculture & Technology,
Bhubaneswar-751 003, Orissa.

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34. THE GROWTH PATTERN OF *PEGAEOPHYTON GARHWALENSIS* (BRASSICACEAE)

(*With a text-figure*)

Alpine vegetation of the Himalaya includes some curious and unusual forms like "hot house plants", "snow ball forms", "rosette forms", "cushion forms", "prostrate growth forms", "aculescent habit", etc. These different morphological forms have adaptive value which ensures the survival of the plants in the harsh climatic conditions of the alpine zone (Ohba 1988, Rawat *et al.* 1994, Semwal *et al.* 1981).

Pegaeophyton garhwalensis Chowdhery et Singh (Brassicaceae), an endemic species of Garhwal Himalaya, shows a mat forming habit which is also adopted by several other alpine plants. This species shows a high degree of habitat specificity. The characteristic habitat of the species lies between 3700 to 4800 m a.s.l. where it grows among the large boulders with dense cover of moss on thin soil layer. *Pegaeophyton garhwalensis* shows characteristic growth pattern which is described below.

Pegaeophyton garhwalensis is a mat forming perennial plant. It was noticed at the end of the growing season (September-October) that the branches carry a dense rosette of leaves with sheathing bases. The leaf sheaths encircle and protect two types of buds (telescopic shoots). In the next growing season after the snow-thaws in June, the buds grow and one of the buds grows up vertically projecting slightly above the moss layer. This shoot during the monsoon season (July-August) gives rise to a terminal lax rosette of leaves with no leaf sheaths. A few flowers (2-4) are borne in the centre of this rosette. This shoot can be called the shoot of definite growth or flowering shoot.

The second bud grows horizontally and a dense terminal rosette of leaves (with broad leaf sheaths) is borne at the terminal end. This shoot is thicker and smaller than the flowering shoot. The terminal rosette bears two buds between leaf sheaths which again gives rise to flowering shoot and vegetative shoot in the next growing season after the winter dormancy. This pattern of growth is followed each year.

In the flowering shoot a characteristic elongation takes

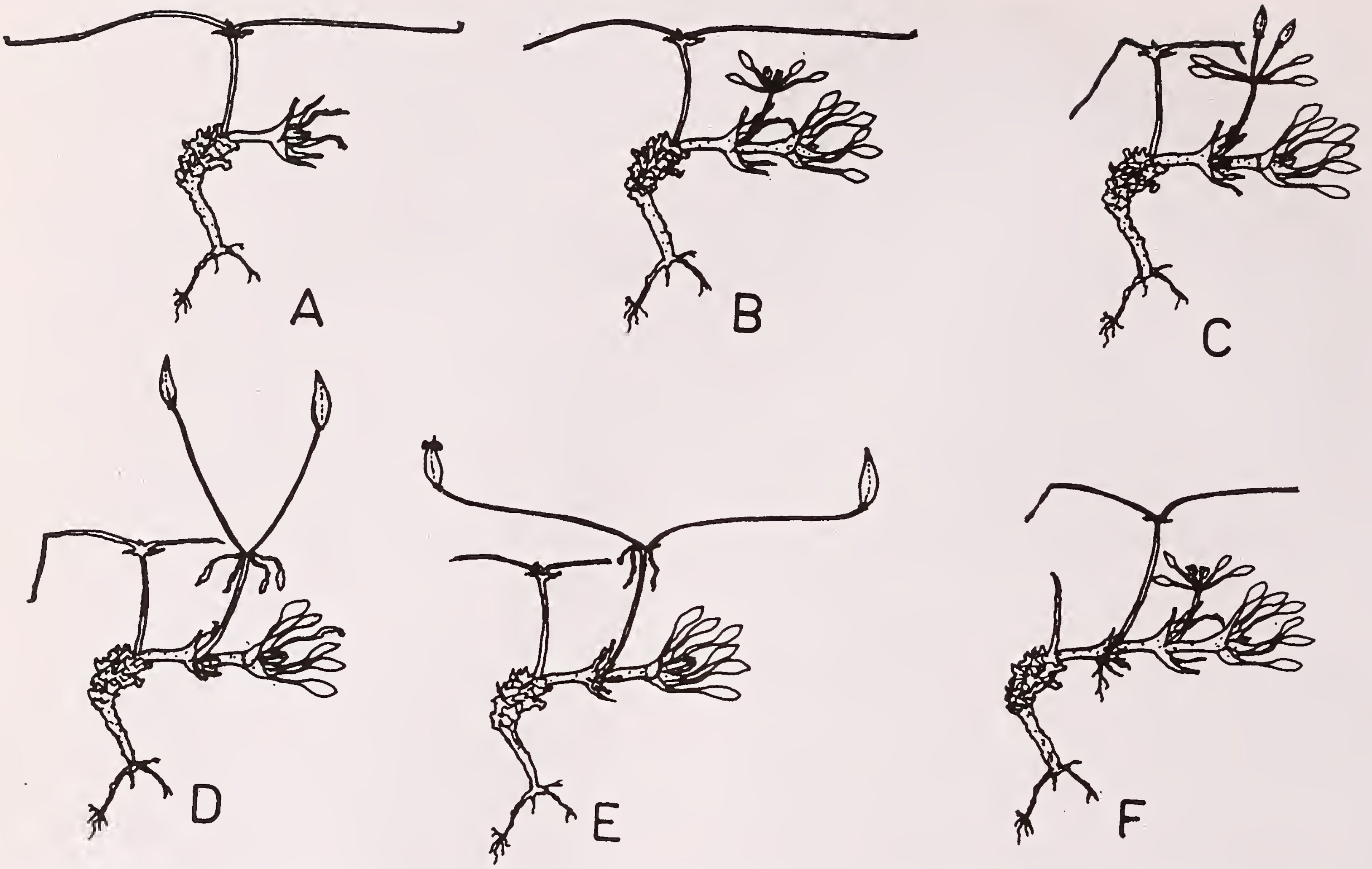

Fig. 1. Growth pattern of *Pegaeophyton garhwalensis:* A. Plant during May; B. Plant during June; C. Plant during July; D. Plant during August; E. Plant during September; F. Plant during next June

place after flowering. This elongation raise the immature fruits far above the moss layer. After fruit maturation the pedicel of the fruit which remains upward in flower moves downward and makes a right angle with flowering shoot that bear it.

Such a growth pattern is the response of the species to the environment of alpine zones to ensure its survival. *Pegaeophyton garhwalensis* tends to keep its perennation buds close to the ground to reduce abrasive damage to the perennating buds.

The vegetative shoot which grows parallel to the ground is thicker than the flowering shoot. Obviously more biomass is accumulated in vegetative shoot while the flowering shoot has less biomass but this shoot also produced seeds which may develop into new plants. In this way survival of the plant is ensured by both means, one through the seeds but with less resource investment and the other with vegetative perennation of buds with higher resources investment.

Leaf sheaths on the vegetative shoot completely encircle the perennating buds providing them protection while the leaves on flowering shoot do not have leaf sheaths. This is another example of economy in resource investment in the alpine zones where energy and nutrient resources are limited.

The raised postiion of inflorescence provides more exposure to flowers for pollination. Elongation in flowering shoot and movement of fruit pedicel are helpful in seed dispersal.

ACKNOWLEDGEMENTS

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June 16, 1994

D.S. RAWAT
L.R. DANGWAL
R.D. GAUR
Department of Botany, P.O. Box-86,
H.N.B. Garhwal University
Srinagar (Garhwal), U.P.-246 174.

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35. LECTOTYPIFICATION OF *BAUHINIA ORNATA* KURZ (LEGUMINOSAE: CAESALPINIOIDEAE)

Larsen and Larsen (1980: 41) cited *Kurz* 2579 (CAL) from 'Choungmenach, Pegu Yomah, Burma' as the lectotype of *Bauhinia ornata* Kurz but the one specimen *Kurz* 2579 (CAL) from 'Choungmenah chg., E. and W. slopes, Pegu Yomah, Burma' is sterile and unannotated by the Larsens. In addition to this specimen there are, however, four more flowering and a sterile collection of Kurz in CAL with the same number, i.e. *Kurz* 2579 but the locality is only 'Pegu' instead of 'Choungmenach, Pegu Yomah'. Recently Prof. Kai Larsen (pers. comm. 1992) kindly informed me that they did not lectotypify the name because the taxon does not occur in Thailand and Indochina. Earlier, Thothathri (1965: 134) had cited *Kurz* 2579 (CAL) from 'Choungmenach, Pegu Yomah, Burma' simply as a type material but annotated it as an isotype. So it seems that Larsen and Larsen (1980) inadvertently cited the above specimen as the lectotype. Prof. Larsen (pers. comm. 1988) drew my attention to a type of *B. ornata* in K, noting that does not fit with the protologue because its ovaries are pubescent along the sutures instead of being woolly all over. However, observations on two specimens: *Kurz* 2579 from 'E. and W. slopes, Pegu Yomah, Burma' (K, photos-CAL!) show that they match well with the protologue.

Thus from the aforesaid original materials I designate here one flowering specimen: *Kurz* 2579 (CAL) from 'Pegu, Burma' having acc. no. 137296 as the lectotype of *B. ornata* Kurz.

Acknowledgements

I am grateful to Prof. Kai Larsen for his comments, Dr. Dan H. Nicolson for suggestions and Director, Royal Botanic Gardens, Kew for providing the photographs of the Kew specimens.

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S. BANDYOPADHYAY
Botanical Survey of India,
P.O. Botanic Garden,
Howrah-711 103.

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36. TERATOLOGY OF WINGED FRUITS IN *TERMINALIA BIALATA* STEUDEL (COMBRETACEAE) — THE ANDAMAN ASH OR WHITE CHUGLAM TREE

In India, the occurrence and distribution of *Terminalia bialata* Steudel is restricted only to Andaman group of islands (not reported from Nicobar group). Generally, the butterfly or moth shaped beautiful biwinged fruits (about 5.0 cm long and 10.0 cm across) are produced by the plant which enables them to reach distant places by dispersal mechanism. While studying the ethnobotanical uses of the fruits of *T. bialata* (The Andaman Ash or White Chuglam Tree), some of the fruits were found to possess four fully developed wings instead of two wings, this unique and rare feature has not been hitherto reported. This teratological or abnormal growth of wings probably facilitates the fruits to reach still further by air dispersal.

The kernels are eaten by the tribals, Onges, Jharawas, Great Andamanese, Sentenelese and Shompens, and settler populations inhabiting the Bay Islands owing to their cashew like taste.

June 16, 1994

P.S.N. RAO
MARCEL TIGGA
Botanical Survey of India
Andaman & Nicobar Circle
Haddo, Port Blair-744 102.

37. NOMENCLATURAL NOTES ON AN INDIAN PLANT

The genus *Senecio* L. finds world wide distribution except Antarctica. It has close affinities with the genus *Ligularia* Cass. The generic limits of the two may, however, be distinguished on the basis of following characters (Jeffrey *et al.* 1977, Jeffrey and Chen Yi Ling, 1984, Nordenstam and Rechinger 1989).

1a. Leaf-base exauriculate; margins of lamina not revolute. Filament column dilated at base. Anther collor balusterform with enlarged marginal basal cells; endothecial tissue, cells elongate. *Senecio*

1b. Leaves with vaginate sheathing bases; margins of lamina revolute. Filament column cylindric, not dilated at base. Anther collar cylindric or obconic, without enlarged marginal basal cells; endothecial tissue cell wall thickenings polarised, cells short .. .. *Ligularia*

Based on above characters, many species of *Senecio* L. have recently been transferred to the genus *Ligularia* Cass. (Rao *et al.* 1988). *Senecio yakla* described by Clarke (1876) from Sikkim, takes its name from the pass known as Yak-La in East Sikkim. Hooker (1881) reduced it to the synonymy of *Senecio amplexicaulis* Wall. ex Clarke; the latter is presently being considered synonymous to *Ligularia amplexicaulis* DC. (Rao *et al.* 1988). Smith (1913) treated *S. yakla* as a distinct species mainly characterised in the involucral bracts being 16-18, acute or obtuse, *c.* 1 cm long, connate below, slightly pubescent and ligule being 16-18, broadly obovate or elliptic, hardly exceeding the involucral bracts. In *S. amplexicaulis* Wall. ex Clarke the involucral bracts vary from 10-12 and ligule 7-8, exceeding involucral bracts, linear-lanceolate. To determine the taxonomic status and systematic position of *S. yakla* Clarke, we examined some specimens of both species at Central National Herbarium (CAL) and concluded that *S. yakla* deserves specific recognition as delimited by Smith (1913), and since it comes within the present generic limits of *Ligularia* Cass., it is proposed to transfer it to the latter as under:

Ligularia yakla (Clarke) V. Singh & P. Singh *comb. nov.*

Senecio yakla Clarke, Comp. Ind. 204. 1876; W.W. Smith, Rec. Bot. Surv. India 4: 384. 1913. *S. amplexicaulis* Hook. f., Fl. Brit. India 3: 348. 1881, *pro parte,* non Wall. ex Clarke 1876.

Specimen studied: INDIA: Sikkim; Changu, 3660 m 26th Oct. 1910, *Ribu & Rhomoo* 4370 (CAL); Chola range, 3960-4270 m, 22nd July 1910, *W.W. Smith* 3697 (CAL); Tanka la, 4570 m, 3rd Aug. 1892, *G.A. Gammie* 536 (CAL).

Distribution: India (Sikkim) endemic.

March 9, 1995

V. SINGH
P. SINGH
Botanical Survey of India, Baluwakhani,
Gangtok-737101, Sikkim.

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38. DESTRUCTION OF *CUSCUTA REFLEXA* ROXB. BY THE RHESUS MACAQUE *MACACA MULATTA* (ZIMMERMANN)

On the afternoon of 26th November 1993, I observed a troop of Rhesus Macaque *Macaca mulatta* (Zimmermann) feeding on *Cuscuta reflexa* Roxb. inside the Keoladeo National Park, Bharatpur, near the eastern wall of the park. Three large sized *Zizyphus mauritiana* Lamk. trees harboured a massive growth of the phanerogamic total stem parasitic twiner *Cuscuta.* Members of the macaque troops were present on all the three *Zizyphus* plants and were plucking and devouring the *Cuscuta* tender growth.

It is worth placing on record Rhesus Macaque as one of the potential *Cuscuta* destroyers in nature.

March 12, 1994

SATISH KUMAR SHARMA
Range Forest Officer,
Aravalli Afforestation Programme,
Jhadol (F.) Udaipur (Raj.)-313 702.

39. FRUIT MORPHOLOGY AND FURTHER DISTRIBUTION OF *CEROPEGIA JAINII* ANSARI AND KULKARNI

Ceropegia jainni Ans. *et* Kulk. was described by Ansari & Kulkarni (1980). The original description does not include the description of the fruit. Which is described here along with further distribution localities.

Ceropegia jainii Ans. *et* Kulk. An erect pernnial herb, 5-12 cm tall, tubers subglobose, 3-5 x 2-4 cm. Stem unbranched, hirsute. Leaves subsessile to petiolate; lower ones elliptic, upper elliptic — linear, 2-5 x 0.5-1.0 cm, hirsute above, glabrous except on the nerves beneath; petioles 1-2 mm long, hairy. Flowers axillary, solitary. Pedicels 4-6 mm long, hairy; bracts subulate, 1-2 mm long. Calyx divided, attached to the base; sepals 2-2.6 mm long, glabrous, subulate. Corolla purplish above, greenish below, up to 2 cm long, curved; tube 9-10 mm long, subcylindric, pale greenish inside with longitudinal purple lines, base inflated in lower half part, glabrous; lobes 9-10, purple or reddish, linear oblong, glabrous outside, densely hairy inside at ovate-deltoid base, acute and connate at apex. Corona biseriate; outer corona cupular of 5 deeply bifid deltoid lobes, hairy along margins; the inner one of 5 linear subspathulate erect lobes. Pollen masses ascending, minute yellow. Gyanostegium *c.* 2 mm long.

Follicles in pairs, 5.2-5.7 x 0.3-0.4 cm, straight, terete, tapering at apex to a fine point, glabrous, greenish yellow. Seeds 12-14 in each follicle, small, comose, 4-5 x 1.5-2 mm, ovate-oblong, prominently margined, compressed, brown. Coma *c.* 1 cm long.

Flowering: August-September.

Fruiting: Very rare, October-November.

Herbarium specimen examined: MPB — 3740 A & 3740 B, deposited at Herbarium, Shivaji University, Kolhapur.

Distribution: The species has only been recorded so far from Ambolighat, Sindhudurga district. It has been now recorded from Kas and Chalkewadi, Satara district and from Ramghat, Sindhudurga district. Endemic to Maharashtra.

Field notes: The species grows on Plateau land among grasses in open situations and also in crevices of rocks. The tubers are eaten by the local people and this may account for its scarcity and its disappearance.

Vernacular name: Galundi, Somandi.

ACKNOWLEDGEMENTS

We are greatly indebted to Dr. V.N. Naik, Rtd. Reader, Marathwada University, for critically going through the manuscript.

June 16, 1994

M.P. BACHULKAR
Botany Deprtment, Lal Bahadur Shastri College, Satara-415 002.
S.R. YADAV
Botany Department, Goa University, Goa-403203.
S.K. LIMAYE
Aryangla Vaidyak Mahavidyalaya, Satara-415 002.

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40. *AXONOPUS COMPRESSUS* (SW.) BEAUV. AND *PHALARIS MINOR* RETZ. (POACEAE) — NEW RECORDS FOR ANDHRA PRADESH

(With two text-figures)

Plant collections made during the botanical exploration in the State of Andhra Pradesh have resulted in locating two grasses, namely *Axonopus compressus* (Sw.) Beauv. and *Phalaris minor* Retz. not known earlier from this state, which are being reported here. They are described and illustrated. The herbarium specimens have been deposited in the herbarium of the Department of Botany, Sri Krishnadevaraya University, Anantapur (SKU).

Axonopus compressus (Sw.) Beauv., Ess. Agrost. 12 (154): 167. 1812; Bor 278. 1960. *Milium compressum* Sw., Nov. Gen. Pl. 24. 1788. (Fig. 1).

An annual grass. Culms up to 25 cm tall, decumbent, spread on the floor like mat, nodes densely bearded with white hairs. Leaf sheaths compressed, 4-7 cm, keeled, glabrous; ligule membranous; blades 5-20 x 0.8-1.5 cm, oblong, flat, rarely folded, base rounded, margin with tuberculate based hairs, apex obtuse-acute, prominently nerved, glabrous. Spikes up to 12 cm long, sub digitate, rachis flexuous. Spikelets 2.5 mm, oblong, secund, alternate, deciduous. Lower glume absent; upper glume oblong, obtuse, hairy on the outer surface, nerves obscure; lower lemma oblong, acute, hairy on the outer surface, nerves obscure, membranous; upper lemma oblong, scaberulous, at apex apiculate, coriaceous; palea oblong, glabrous. Stamens 3, stigmas plumose. Caryopsis obovoid-ellipsoid.

Occasional in moist areas along road verges and water courses in Chittoor and East Godavari Districts. *Fl. & Fr.*: Oct.-Mar. Tirumala hills (CTR), *MSG* 12168; Maredumilli (EG), *TP & MSG* 12264.

Phalaris minor Retz., Obs. 3: 8.1783; FBI 7: 221.1896; Bor 616.1960. (Fig. 2).

An annual tufted grass. Culms up to 60 cm tall; nodes glabrous. Leaf sheaths 3-9 cm, glabrous, loose; ligule membranous; leaf blades linear, 5-15 x 0.3-0.5 cm, flat, base sub-cordate, apex acuminte, glabrous. Spike like panicle up to 5 cm long, dense, ovate-oblong. Spikelets all alike, 5 mm, solitary, sterile florets present; pedicels

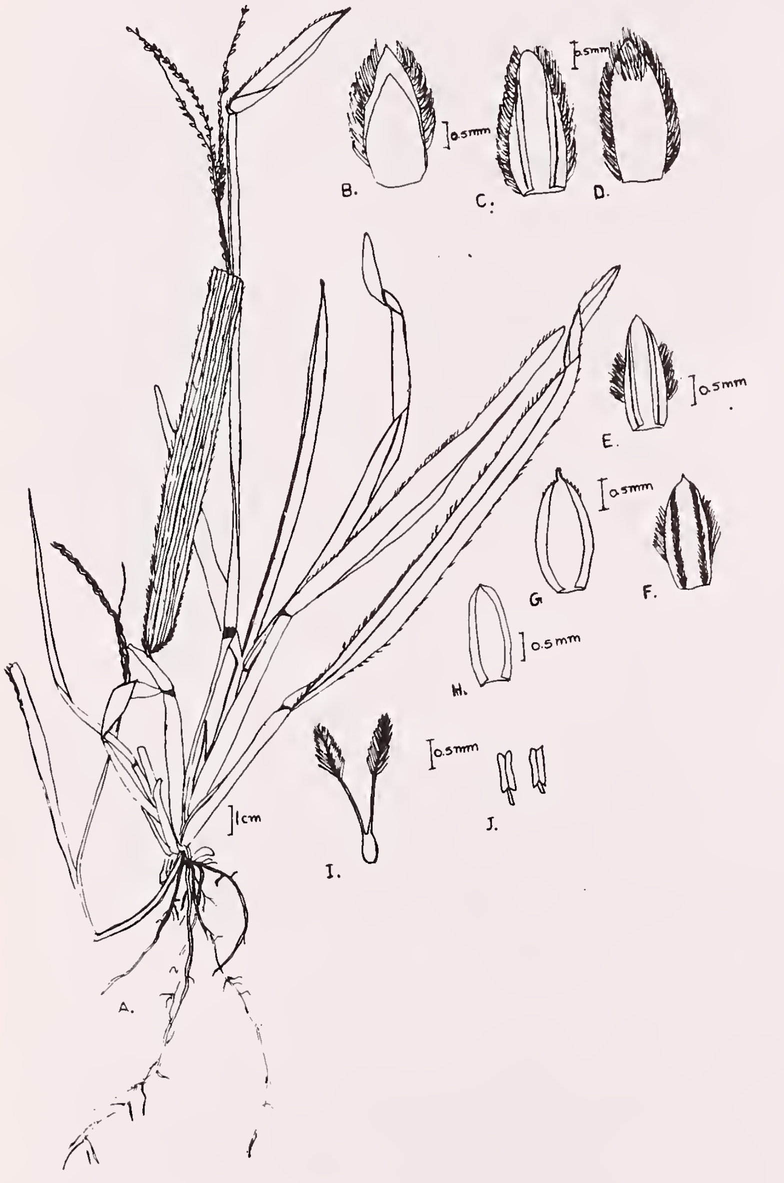

Fig. 1. *Axonopus compressus* Beauv.

A. Twig, B. Spikelet, C. & D. Upper glume front and back views, E. & F. Lower lemma front and back views, G. Upper lemma, H. Palea, I. Pistil, J. Stamens.

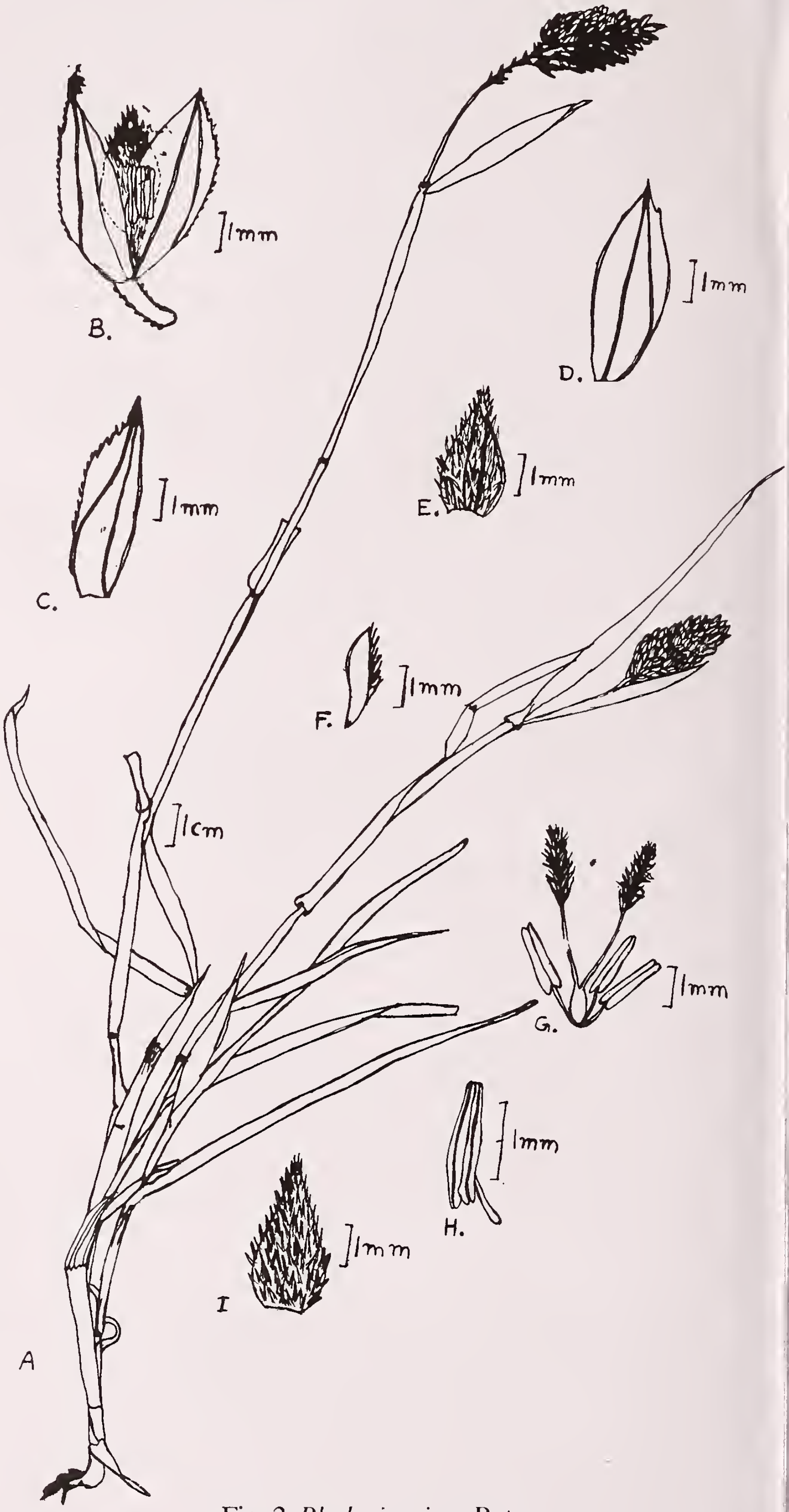

Fig. 2. *Phalaris minor* Retz.

A. Twig, B. Spikelet, C. Lower glume, D. Upper glume, E. Lemma, F. Palea, G. Pistil with stamens, H. Stamen, I. Caryopsis.

scabrid. Glumes equal, 5 mm, membranous, boat-shaped, broadly winged, the wing margin denticulate, prominently 3-nerved, enclosing the floret; sterile lemma 2 mm, glabrous; fertile lemma 3 mm, pubescent, broadly ovate, 1-nerved; palea narrowly linear, bisexual. Stamens 3, stigmas plumose. Caryopsis ovoid, pubescent.

Occassional on waste lands in Tirumala hills of Chittoor district. *Fl. & Fr.*: Oct.-Mar. Tirumala hills (CTR), *MSG* 12160.

We thank Dr. P.V. Prasanna, Scientist,Botanical Survey of India, Pune for his help in identification.

June 16 1994

M.S. GAYATHRI
T.PULLAIAH
Department of Botany,
Sri Krishnadevaraya University,
Anantapur 515 003, A.P.

ERRATA

Vol. 91, No. 2

FURTHER OBSERVATIONS ON PHAYRE'S LEAF MONKEY (*TRACHYPITHECUS PHAYREI*) IN CACHAR, ASSAM

on p. 209, Conclusion, line 3,

For 30 sq. km

Read 530 sq. km

Miscellaneous Note No. 13. The ringed plover (*Charadrius hiaticula tundrae* Lowe)
in Sri Lanka and peninsular India
On p. 316, Left column, lines 15, 16

For whereas Balachandran their status assessment.

Read whereas Balachandran confirms their status assessment.

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GROUP SIZE AND AGE-SEX COMPOSITION OF THREE MAJOR UNGULATE SPECIES IN GIR LION SANCTUARY, GUJARAT, INDIA[1]

JAMAL AHMAD KHAN[2], RAVI CHELLAM AND A.J.T. JOHNSINGH[3]

(*With two text-figures*)

Key words: Age-sex ratio, Gir Lion Sanctuary, grouping characteristics, management, *Axis axis, Cervus unicolor*

Grouping characteristics and population structure of chital (*Axis axis* Erxleben), sambar (*Cervus unicolor* Kerr) and nilgai (*Boselaphus tragocamelus* Pallas) were studied in Gir Lion Sanctuary, Gujarat, during 1987-89. Data on group size and age-sex composition of different species were collected during 82 monitoring of eight line transects and 153 road-strip counts conducted in summer 1987, winter 1988, winter 1989 and summer 1989. There were 492 and 3132 km of monitoring of line and road transects respectively. All three species showed positively skewed group size. Mean group size was highest for chital (6.03±5.9) and lowest for sambar (1.8±1.0). The mean group size varied significantly among seasons for chital and nilgai. The mean group size values, however, did not differ significantly between different years for all three ungulate species. The values of typical group size were significantly larger than other estimates of group size for all species. All three species showed biased sex ratios in favour of females in different seasons and years. The adult males to females ratio was lowest for chital (41:100 females) and highest for nilgai (71:100 females). The results agree broadly with findings from other wildlife areas in the Indian subcontinent.

INTRODUCTION

The pioneering work of Schaller (1967) in Kanha Tiger Reserve was the first ecological description of some of the common ungulate species found on the Indian subcontinent. Since then, there have been several studies on ungulates in this region (e.g. Eisenberg and Lockhart 1972, Berwick 1974, Sharatchandra and Gadgil 1975, Dinerstein 1980, Mishra 1982, Johnsingh 1983, Barrette 1991). Data on different population characteristics (e.g. grouping structure, densities, age-sex ratios), have contributed significantly towards a better understanding of these ungulate species.

The current level of information on various ecological aspects is, however, far from satisfactory even for the most abundant and widely distributed ungulate species in the region, i.e. chital (*Axis axis* Erxleben). Extensive research in Africa and North America (on ungulates) has, on the contrary, not only provided sound ecological data for their intensive management but has allowed some useful generalizations on various ecological and behavioural aspects of numerous ungulate species (e.g. Jarman 1974, McNaughton and Georgiadis 1986, Miquelle *et al.* 1992). Thus there is still a need to gather more information on all ecological aspects of south Asian ungulates to fill the gaps in the existing information as well as to strengthen the management of species and protected areas. The ungulate community of Gir Lion Sanctuary comprises of chital, sambar (*Cervus unicolor* Kerr), nilgai (*Boselaphus tragocamelus* Pallas), chowsingha (*Tetracerus quadricornis* Blainville), chinkara (*Gazella gazella* Pallas) and wild pig (*Sus scrofa* Linn.). This paper describes the grouping characteristics and population structure of chital, sambar and nilgai. Data for this study were collected under a research program initiated by the Wildlife Institute of India in 1986.

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[1] Accepted June 1994.

[2] Conservation Ecology Research Group, Centre of Wildlife & Ornithology, Faculty of Life Sciences, A.M.U. Aligarh-202 002, India.

[3] Wildlife Institute of India, P.O. Box 18, Chandrabani, Dehradun (U.P.).

Study Area

Gir Lion Sanctuary and National Park situated in Kathiawar peninsula of Gujarat covers an area of 1412 sq. km. Gir is divided into three management units, i.e. Sanctuary West, National Park and Sanctuary East. These units differ in terms of vegetation, water availability, topography, human settlement density and, hence, degradation. Sanctuary West is relatively thickly wooded and has good water availability throughout the year. The topography is a series of undulating hills and extensive flat plain areas. National Park is densely wooded and has relatively low water availability. Sanctuary East has open vegetation and medium water availability throughout the year. Grazing by livestock of Maldharis (a pastoral community) is most intense in Sanctuary East and least in National Park. Rainfall data over the past 28 years indicates that the average rainfall in the Sanctuary West is approximately 1000 mm and it is 800 mm in Sanctuary East. Seasons are distinct. December through March is winter (average minimum temperature 9° C) followed by a hot summer (average maximum temperature 42°C), till mid June. Monsoon breaks in June and continues till September which is followed by a dry post monsoon season till mid-December.

The vegetation of Gir is tropical dry deciduous interspersed with tropical thorn forest (Champion and Seth 1968). Teak (*Tectona grandis* Linn.), forms the principal species and nearly 70% of the total area of Gir is covered with teak and its several associates. The vegetation changes along a west to east axis, from thickly wooded teak forest to open thorny *Acacia-Zizyphus* woodlands. Teak is replaced by *Anogeissus latifolia* (Roxb.), in the east.

Methods

Data collection was started in January 1987 and continued for 36 months till December 1990. Data on group size and age-sex ratios of all three ungulate species were collected during monitoring of line transects (Burnham *et al.* 1980), and road-strip counts (Hirst 1969, Berwick 1974), conducted to estimate ungulate densities (Khan *et al.* 1990). Eight line transects, each 6 km in length, and placed in stratified random fashion, were marked permanently in three units (three each in Sanctuary West and National Park and two in Sanctuary East). The line transects were monitored on seasonal basis by JAK (the first author), from December 1987 to May 1989, from 0630 hours to 0930 hours. There were 82 monitoring of line transects and each transect was, on an average, monitored twice in a season. The road-strip counts were conducted during summer of 1987, winter of 1988, winter of 1989 and summer of 1989. During each count, the existing road network of 700 km in Gir was divided into transects of almost equal lengths (average 20 km). Each road transect was monitored in morning hours and again repeated in the evening. There were 652, 679, 953 and 848 km of road transects monitored during the four counts respectively.

Group size and composition were recorded for all sightings. The animals were classified into adult male (AM), adult female (AF), yearling (YRN) and fawns (FN) following the classification adopted by Schaller (1967), Eisenberg and Lockhart (1972) and Mishra (1982). Line transect and road-strip count data were pooled for three years together and season-wise to estimate frequency distributions of group sizes, sex ratios, mean group size (MGS), median of group (MDG), median of individuals (MDD) and typical group size (TGS) following Barrette (1991). MDD and TGS are animal-centered measurements of group size reflecting the experience of average individuals in a group and are better compared to MGS and MDG which are observer-centered estimates of group size (Barrette 1991).

One way analysis of variance (ANOVA) was used to test significance of differences in MGS values for each species between seasons and years. z-test was used to test differences between overall MGS and TGS values for each species. Chi-square test was used to test differences in age-sex composition of each species between different seasons and years. All statistical tests were performed following Fowler and Cohen (1986).

RESULTS

Grouping characteristics: Chital was the most gregarious compared to sambar and nilgai. While chital group size ranged from one to more than 50 individuals, that of sambar and nilgai ranged from one to five and one to eight respectively. All species showed positively skewed group sizes as large number of groups were seen in smaller size classes compared to bigger ones (Figs. 1 & 2). For instance, there were 15.5%, 50% and 51% groups of one individual of chital, sambar and nilgai respectively. This was, however, not the case with distribution of individuals in groups, as for example, there were 2.5%, 28% and 25% individuals in size class one for chital, sambar and nilgai respectively. These striking differences in distribution of groups and individuals in them were obvious in other size classes too which suggests that distribution of groups as well as average group size estimates based on it (e.g. MGS) may not provide realistic picture of social structure of a species since these would be influenced by extreme values or the skewed nature of the group size data. The TGS values were higher compared to MGS values and other measurements of group size (MDG & MDD). The difference between TGS and MGS were large and significant for chital (z= 336.2, P <0.01), sambar (z= 133.3, P <0.01) and nilgai (z= 76.4, P <0.01).

There was a clear pattern of seasonal variation in MGS for each species with group size being lowest

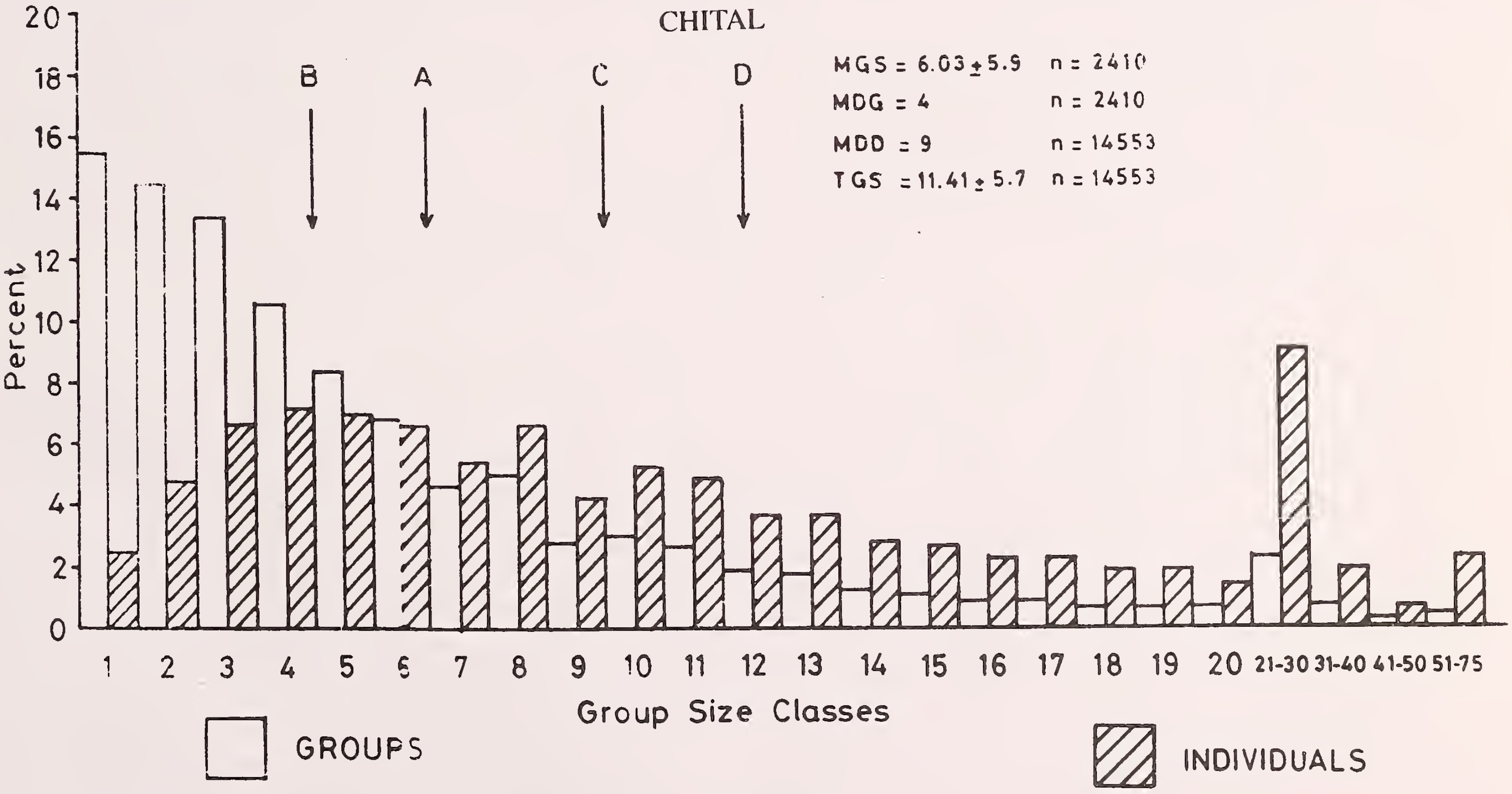

Fig. 1. Frequency distribution of groups and individuals with four descriptions of chital group size. A=Mean group size (MGS), B=Median of groups (MDG), C=Median of deer (MDD), D-Typical group size (TGS).

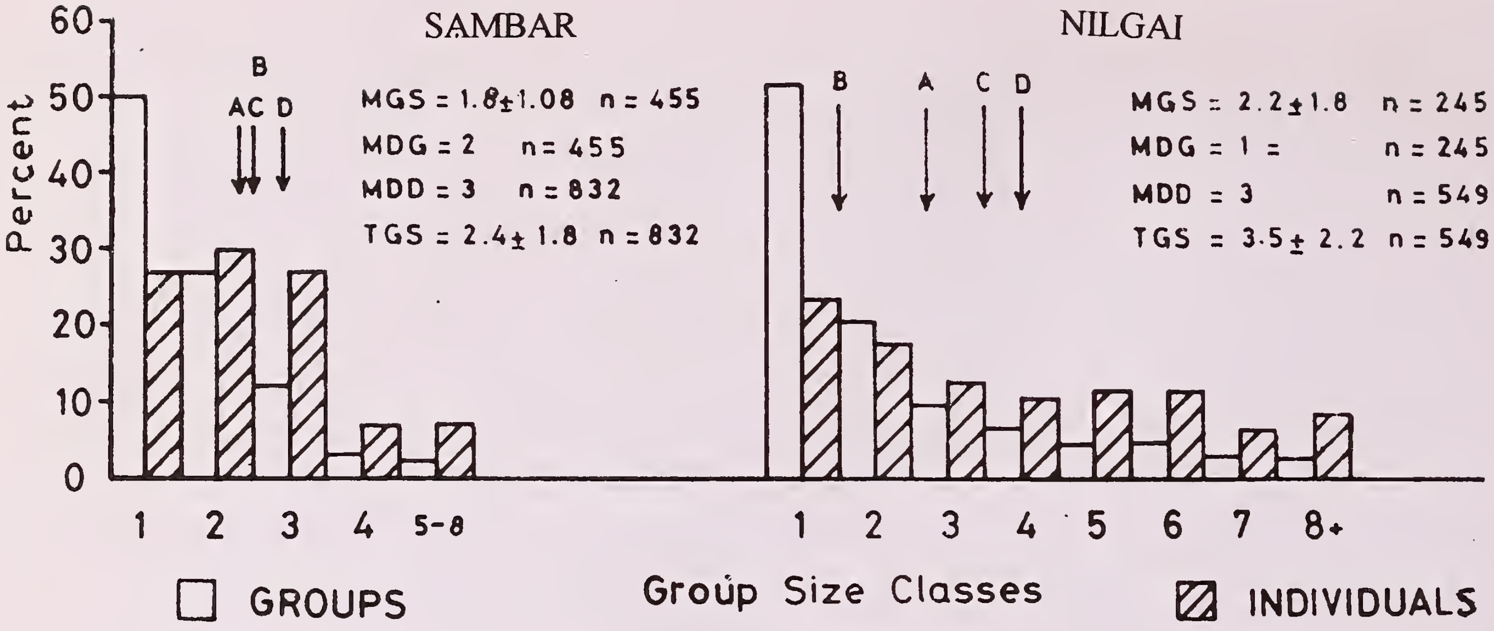

Fig. 2. Frequency distribution of groups and deer with four descriptions of sambar and nilgai group size. A=Mean group size (MGS), B=Median of groups (MDG), C=Median of deer (MDD), D=Typical group size (TGS).

during summer and highest in monsoon season (Table 1). The seasonal variation was significant for chital ($F_{3,6}$ = 48.4, $P < 0.05$), nilgai ($F_{3,6}$ = 16, $P < 0.05$), but not for sambar ($F_{3,6}$ = 0.076, $P > 0.05$). However, there was no significant variation among years in MGS values for any species which suggests that MGS is a relatively stable parameter and does not fluctuate widely between different years.

Sex and age ratios: Table 2 provides the proportions of various age-sex categories of chital, sambar and nilgai in different seasons and years in Gir. The proportions of different age-sex categories of chital differed significantly among seasons (X^2=69.02, d.f. = 6, P <0.001) and years (X^2=134.2, d.f.=6, <0.001). These differences were largely associated with the changes in proportions of yearlings between seasons

TABLE 1

MEAN GROUP SIZE VALUES FOR MAJOR UNGULATE SPECIES DURING DIFFERENT SEASONS IN GIR

Seasons	Chital			Sambar			Nilgai		
	n	MGS	S.D.	n	MGS	S.D.	n	MGS	S.D.
Winter 1987	151	6.2	5.4	10	1.9	0.99	10	2.7	2.0
Winter 1988	627	4.4	3.7	143	1.8	1.06	95	2.4	2.1
Winter 1989	306	6.4	8.0	42	1.5	0.70	32	1.8	1.2
Summer 1987	503	5.1	4.7	103	1.7	1.02	28	2.5	1.6
Summer 1988	62	5.8	4.6	70	1.9	0.90	31	1.8	1.5
Summer 1989	505	5.9	5.8	37	1.9	1.01	19	1.8	1.2
Monsoon 1987	69	9.8	7.2	40	2.3	1.80	23	3.1	2.1
Monsoon 1988	117	8.8	15.3	35	2.2	1.90	13	3.3	2.2
Monsoon 1989	102	9.5	7.2	20	2.1	1.80	15	3.0	2.8
Post-monsoon 1987	123	5.6	4.6	14	1.7	0.97	16	2.0	1.3
Post-monsoon 1988	27	4.9	2.5	28	1.8	1.00	28	2.1	1.5
Post-monsoon 1989	65	4.3	4.0	18	1.7	1.20	8	1.9	1.1

(n=Group classified, MGS=Mean group size, S.D.=Standard deviation).

Table 2
PROPORTIONS OF DIFFERENT SEX-AGE CATEGORIES FOR THREE UNGULATE SPECIES IN DIFFERENT SEASONS AND YEARS

	Chital					Sambar					Nilgai				
	n	AM	AF	YRN	FN	n	AM	AF	YRN	FN	n	AM	AF	YRN	FN
Seasons															
W	4835	24.3	51.9	9.1	14.4	301	31.5	53.8	3.6	10.9	315	34.2	49.8	2.2	13.6
S	4348	20.0	54.3	12.9	12.6	386	30.0	58.5	4.9	6.4	227	41.4	43.6	3.9	11.0
M	1374	21.7	56.1	9.3	12.7	99	37.3	62.6	-	-	78	24.3	70.5	-	-
PM	805	21.7	56.6	8.8	12.7	35	28.5	65.7	-	-	9	-	-	-	-
Years															
1987	3074	21.8	55.7	7.2	15.0	231	29.8	57.1	6.0	6.9	201	39.3	44.2	2.9	13.4
1988	3610	21.7	56.1	8.0	14.0	486	29.8	60.6	2.2	7.2	333	32.4	56.1	1.2	10.2
1989	4681	22.7	50.4	14.8	11.9	104	42.3	44.2	5.7	7.6	95	40.0	41.0	6.0	12.6
Overall	11365	22.2	53.7	10.6	13.4	821	31.4	57.6	3.7	7.1	629	35.7	50.0	2.5	11.6

n-number of animals classified, AM-adult male, AF-adult female, YRN-yearling, FN-fawn, W-winter, S-summer, M-monsoon, PM-post monsoon.

Table 3
NUMBER OF MALES (AM), YEARLING (YRN) AND FAWNS (FN) PER 100 FEMALES FOR DIFFERENT SPECIES BETWEEN DIFFERENT YEARS IN GIR

	Chital				Sambar				Nilgai			
	n	AM	YRN	FN	n	AM	YRN	FN	n	AM	YRN	FN
Years												
1987	3074	39	13	27	231	52	11	12	201	89	7	30
1988	3610	39	14	25	486	49	4	12	333	58	2	18
1989	4681	45	28	24	104	95	13	17	95	97	15	31

n-number of animals classified.

(component X^2=9.7 & 23.01 for winter and summer) as well as years (component X^2=64.4, 9.0 & 24.8 for 1987, 1988 and 1989). The proportions of age-sex categories of sambar and nilgai were not amenable to chi-square analysis between seasons, while the same differed significantly between the years for sambar (X^2=15.7, d.f.=6, $P< 0.05$) and nilgai (X^2=58.8, d.f.=6, $P< 0.01$). The differences were largely associated with changes in proportions of males and to some extent females between years for sambar and nilgai. On the whole, the proportions of males and females were 22.2% and 53.7% for chital, 31.4% and 57.6% for sambar and 35.7% and 50% for nilgai. The proportion of animals in pre-reproductive age class (yearling and fawn) was 24% for chital, 10.8% for sambar and 14.1% for nilgai.

All three species showed biased sex ratio in favour of females during different seasons and years (Table 3). While male to female and fawn to female ratios were relatively stable for chital between seasons and years, the same showed wide variations for sambar and nilgai, possibly, due to the small sample sizes. The number of males per 100 females was 41 for chital, 54 for sambar and 71 for nilgai.

Similarly, number of fawns per 100 females was 25.8 for chital, 12.4 for sambar and 23.1 for nilgai.

Discussion

A comparison of group size and structure of chital, sambar and nilgai in Gir with data from other wildlife areas face two major limitations. Firstly published studies differ widely in their sampling methodologies and it is difficult to distinguish between real difference and differences due to sampling methods. Secondly, the choice of parameters which could be used for comparison is limited. Most of the workers have used frequency distributions of groups and mean group size for description of group structure and it is only recently that Barrette (1991), recommended the use of frequency distribution of individuals and TGS values for such a description. We have therefore used MGS values of different species only for comparison with other studies.

The overall MGS of chital in Gir is similar to values reported by Karanth and Sunquist (1992) from Nagarahole Tiger Reserve (NTR), and Mishra (1982) from Chitwan National Park (CNP), but it differs from that of Barrette (1991), and Dinerstein (1980) who reported higher MGS values for chital from Wilpattu National Park (WNP), in Sri Lanka and from Royal Karnali Bardia Reserve (RKBR), in Nepal. The MGS values of sambar and nilgai conform to the values reported by Karanth and Sunquist (1992), Mishra (1982) for sambar and Dinerstein (1980) for nilgai. It seems that the observed differences in overall MGS values between Gir and that of RKBR and WNP for chital is due to disproportionate sampling of open areas (open grasslands in RKBR and villus in WNP) as well as total sample size biased in favour of groups from open areas (e.g. 1889 groups from open area vs. 362 groups from forest in case of WNP). As groups of chital are significantly larger in open areas compared to forest (Barrette 1991), the overall MGS value would also be higher.

The overall MGS for chital was significantly higher than that of sambar and nilgai. Similar patterns have been documented by other workers also for these species. There have been attempts to explain interspecific variation in group size of antelopes in Africa (e.g. Jarman 1974) but more work is needed before one could attempt such an exercise for cervids. For instance, the sambar is expected to form bigger groups by virtue of its large body size (Mishra 1982), mixed food habits and as generalists being adapted to a wide variety of vegetation types. However, data proves it to be otherwise. While explanation can be given for smaller group size of sambar on the basis of habitat (closed forest) it occupies (structuralist explanation, Barrette 1991), its solitary nature and antipredator strategies (Johnsingh 1983), no such explanation is available for nilgai. The above explanation for sambar is quite convincing especially if one considers the group size and social organization of swamp deer (*Cervus duvauceli* Cuvier), which is similar to sambar in body size but differs in the habitat type (grassland), it occupies, food habits (grazer), and social organization (highly gregarious, overall MGS value 6.5) (Schaller 1967, Martin 1977).

The significant seasonal variation in MGS values of chital and nilgai, and lack of it in sambar has been documented elsewhere also (Eisenberg and Lockhart 1972, Berwick 1974, Dinerstein 1980, Mishra 1982, Barrette 1991). Except Berwick (1974), findings of these workers conform to the pattern of seasonal change in Gir, i.e. decrease in group size during dry season and increase in rainy season. What are the factors which cause the group size to vary in some ungulates and not in others? The social organization of species has been considered one such factor (Rodgers 1977). Group size in species which exhibit open membership social structure (e.g. chital, swamp deer), may show temporal variation not only on a seasonal basis but also during different times of the day (Sharatchandra and Gadgil 1975, Barrette 1991) whereas species having closed membership social structure (e.g. sambar), lack such variation. For species having open structure, food availability, predation risk and rutting activity (e.g. Hamilton 1971, Vine 1971, Jarman

1974, Sharatchandra and Gadgil 1975, Khan and Vohra 1992) have been considered as the main factors responsible for seasonal change. However, which one of these factors play a major role is not clear. For instance, while Sharatchandra and Gadgil (1975) attributed the increase in group size during rainy season to high food availability, Dinerstein (1980) considered predator detection as the prime reason for bigger group size due to increase in plant cover and density. We believe that an increase in plant cover and density will cause the herds to fragment not only due to purely structural reasons (Barrette 1991), but also because bigger group size will increase the probability of predation as increase in plant cover and density would benefit stalking predators such as lion.

All three ungulate species in Gir showed adult sex ratio biased in favour of females in all seasons. Others have reported sex ratios in favour of females for these species with the exception of Dinerstein (1980) for nilgai and Seidensticker (1976), for chital and sambar. They have reported sex ratios to be otherwise. These exceptions are however based on very small sample sizes and hence may not be considered representative. The disparity in adult sex ratio has been attributed to several factors such as misclassification of individuals (Sharatchandra and Gadgil 1975, Mishra 1982 for chital), higher mortality of male fawns (Schaller 1967, Johnsingh 1983 for chital), and selective predation on males (Berwick 1974 for all three species, Schaller 1967, Johnsingh 1983 for sambar, Karanth and Sunquist 1992 for chital and sambar). No attempt has been made so far to check the sex ratio at birth in the wild and for higher mortality of male fawns. Only Schaller (1967), and Johnsingh (1983) provide some data to substantiate their claims for selective predation on males in sambar. Explanations vary as to what makes males more vulnerable to either selective predation or in general higher mortality. In African bovids subsistence of subadult males on low quality forage as a result of their exclusion from established territories and harassment by dominant males have been considered as major factors for higher mortality of males (Leuthold 1977). In south Asian ungulates, solitary habits, proneness to injuries from intra-specific aggression, lack of alertness during rut and dispersal behaviour have been considered some of the factors which make males more vulnerable to selective predation (Karanth and Sunquist 1992). While Johnsingh (1983) could not find any pattern in dhole (*Cuon alpinus* Pallas) predation on chital males before and after rutting season, no objective information exists regarding influence of other factors. There is clearly a need for more work to explain such disparities with the help of more data.

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SHORE BIRDS OF THE MARINE NATIONAL PARK IN THE GULF OF MANNAR, TAMIL NADU[1]

S. BALACHANDRAN[2]

(*With a text-figure*)

Key words: Dhanuskodi lagoon, Pillaimadam lagoon, Kundugal point, Rameswaram island, Manali island, Hare island, winter visitor, passage migrant, breeding resident, wader, tern, gull

During the bird migration study conducted between 1985-1988 at the Gulf of Mannar Marine National Park area, a total of 187 species of birds were recorded, of which 84 were aquatic species and the remaining terrestrial. The status, population, arrival and departure dates (for the migratory species) of the waders, terns and gulls have been described specieswise. The other aquatic birds are listed groupwise and the terrestrial birds recorded are listed in the checklist. At Manali and Hare islands 23 species of migratory birds were found to oversummer every year. The uncommon waders to India such as knot *Calidris canuta*, eastern knot *Calidris tenuirostris*, curlew *Numenius arquata*, whimbrel *Numenius phaeopus*, and bar-tailed godwit *Limosa lapponica* were recorded as regular winter visitor to this area.

INTRODUCTION

The marine fauna and flora and the physical, chemical and biological features of the coastal habitat around Mandapam in the Ramanathapuram district bordering the Marine National Park are well known (Jayaraman 1954, Prasad 1956, 1958; Sudarsan 1961). However, relatively little is known about the coastal birds. Biddulph (1938) reported on the birds of Rameswaram islands, and Lal Mohan (1985, 1986) on the population, seasonality and recovery of terns.

A visit by Sálim Ali during 1982 and a survey party from the Bombay Natural History Society in August 1985 to Mandapam, (Fig. 1) focused the importance of this area in the migratory movements of wader species and flamingos *Phoenicopterus roseus* in India. The status of the water birds of Mandapam and its neighbouring islands, was studied by the BNHS by a ringing programme between September 1985 and August 1988.

Next to Point Calimere on the south-east coast of India, the Mandapam area has the largest number of bird species (187 species both aquatic and terrestrial) and a large seasonal aquatic bird population of over 50,000. Pelagic birds were also occasionally recorded (Balachandran 1990, 1991). Its geographical situation close to Sri Lanka and the islands in the Gulf of Mannar is of particular importance in the movement of birds.

STUDY AREAS

Mandapam (9° 17' N, 79° 8' E) lies on a narrow peninsula projecting from the south east coast of India, with the Gulf of Mannar to the south and Palk Bay to the north (see Fig. 1). At the end of the peninsular extension is Pamban island which is connected to the mainland by a Railway bridge. The inshore region of the Palk Bay is largely muddy while, in the Gulf of Mannar, it is rocky with small areas of sand and mud in between. At distances ranging from 5-8 km from the mainland, the Gulf of Mannar has a chain of islands running roughly parallel to the coast (Fig. 1). These islands are mainly of coral origin, probably of the nature of fringing reefs. The mixing of waters of Palk Bay and the Gulf

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[1] Accepted June 1994.

[2] Bombay Natural History Society, Hornbill House,
Dr. Sálim Ali Chowk, Shaheed Bhagat Singh Road,
Bombay-400 023. *Present address*: 11/100, Central St., Agasteeswaram P.O., Kanyakumari Dist.-629 701, Tamil Nadu.

takes place through the Pamban pass and also through "Adam's Bridge" between Dhanuskodi and west coast of Sri Lanka (Jayaraman 1954).

The main study areas were the Manali and Hare islands, the Dhanuskodi lagoon, the intertidal area of Kundugal point in the Rameswaram island, and the Pillaimadam lagoon in the mainland near Mandapam (Fig. 1)

Manali island is about 2 km long and 50 meters wide, covering an area of 24 hectares with small water pools and open mudflats. The small creeks inside the islands are fringed with mangrove vegetation and coarse grass. The shore is sandy with extensive coral formation in the intertidal area. Large inshore areas (approximately 1.5 sq.km) are exposed during the low tide.

Hare island is the largest among all the islands with an area of about 56 ha. Due to human interference, the flora and fauna are different from those of other islands. The inshore area is sandy, and mud flats are present at the eastern side the island. As in Manali island, large areas (1.8 sq.km) are exposed during low tide.

The Pillaimadam lagoon adjoining Palk Bay, is about 8 km long encompassing an area of 6 sq.km. The bottom of the lagoon is mostly muddy. The lagoon is bordered by grassy area on the landward side and sand dunes on the seaward side. The salinity fluctuates significantly between monsoon and summer seasons. Small fresh water pools are formed along the border of the lagoon during the monsoon.

Dhanuskodi lagoon, situated on Rameswaram island, extends from Rameswaram road to the lands end at Dhanuskodi. The length of the lagoon is approximately 14 km and the width varies from 0.7 to 1 km. The total area of the lagoon is 11.85 sq.km. The western side of the lagoon is mostly of mud flats and the middle portion is an admixture of sand and clay. The tapering eastern end is sandy.

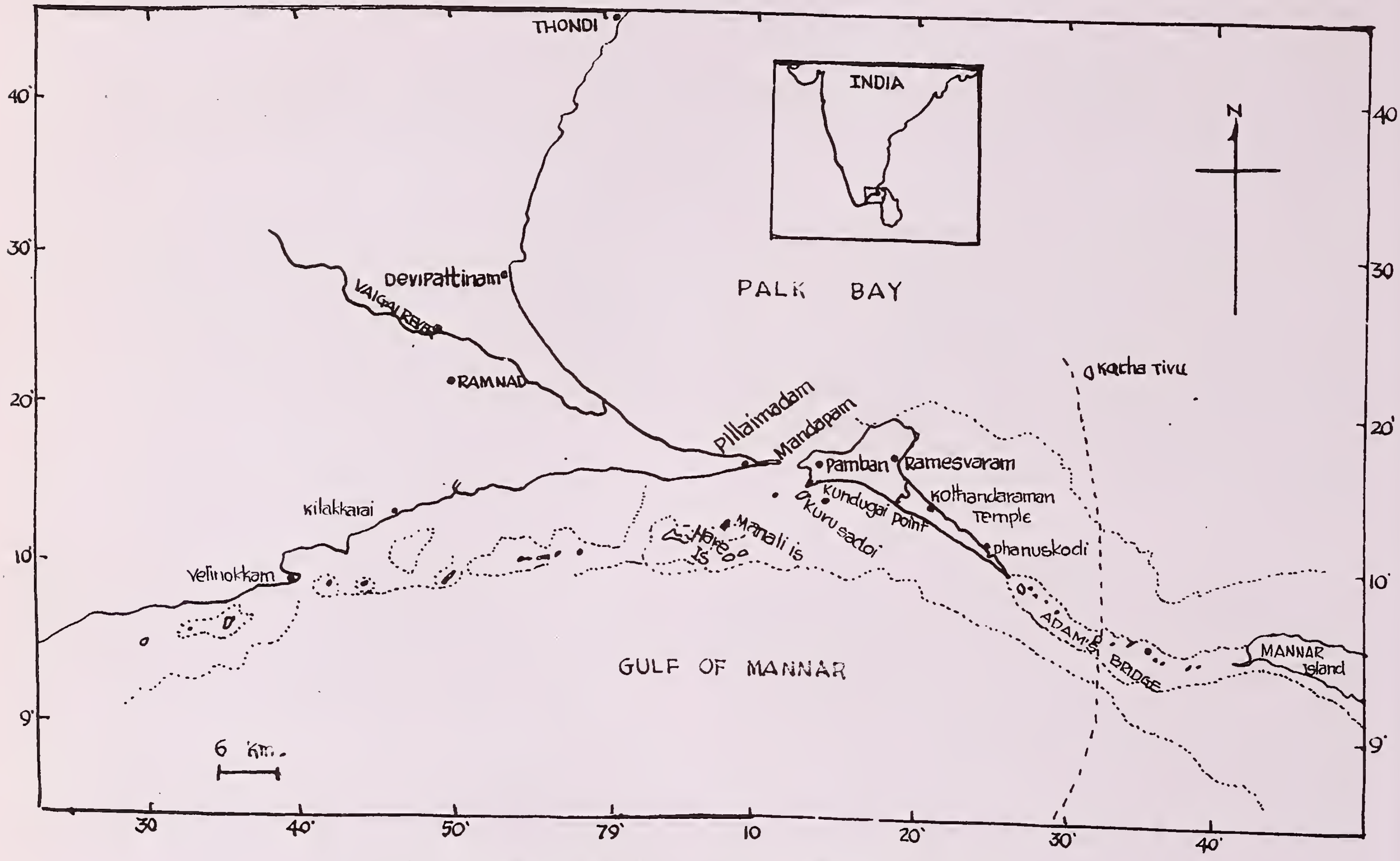
THONDI
INDIA
N
40'
30'
20'
10'
9'
PALK BAY
Devipattinam
VAIGAI RIVER
RAMNAD
Katcha Tivu
Pillaimadam
Mandapam
Pamban
Rameswaram
Kothandaraman Temple
Dhanuskodi
Kundugai Point
Kurusadai
Manali Is
Hare Is
Kilakkarai
Velinokkam
GULF OF MANNAR
ADAM'S BRIDGE
MANNAR Island
6 km.
30
40'
50'
79'
10
20'
30'
40'

Fig. 1. Study area of the Marine National Park, Gulf of Mannar.

CLIMATE

The temperature varies from 22°C to 36°C, Mandapam experiences moderate climatic conditions. North-east monsoon which usually sets in late October brings much of the rain. During the three year study period the rainfall was maximum (1120 mm) in the third year (1987-88) and was lowest (756 mm) in the first year (1985-86), and was moderate (920 mm) in the second year (1986-87).

METHODS

Information collected during bird counts, and data obtained from bird ringing formed the main data base for this study. The study was carried out over three years (1985 to 1988) as a part of the BNHS Bird Migration Project. Each season commenced from September and ended the next August. Thus, 1985-1986, 1986-1987, 1987-1988 seasons are respectively mentioned as "first", "second" and "third" season.

As the study was focused on migratory water birds especially waders, terns and gulls, these groups are described specieswise. Moreover, these species regularly occurred in the study areas. Other aquatic birds such as egrets, herons, ducks and teals are also described groupwise. The land birds of the area are listed in the Appendix.

RESULTS

Oystercatcher *Haematopus ostralegus*

A regular winter visitor in small numbers. Observed on the intertidal habitats of Manali and Hare islands and Kundugal Point. The maximum number recorded was in the year 1985-86. A few subadult birds 3 to 6 summered at the above three sites.

Grey plover *Pluvialis squatarola*

A regular, common, winter visitor occurring in several hundreds, seen in all the habitats. The maximum number of individuals recorded was during October and included passage migrants at Manali island. A considerable number of individuals (50-70) were noticed throughout the summer, especially at Manali and Hare islands.

Eastern golden plover *Pluvialis dominica*

A regular winter visitor. Several hundreds arrive between September and October and depart between March and April. Though a few hundreds were observed throughout the winter their number was maximum during the spring passage (February to March). None were seen during the summer.

Large sand plover *Charadrius leschenaultii*

A regular, common, winter visitor. Arrives in hundreds in September and October and departs in late January and February. A few individuals summer in Manali and Hare islands. Predominantly seen on the two islands, Kundugal Point, and the eastern end of Dhanuskodi lagoon. The maximum number was observed in October due to the occurrence of passage migrants.

Little ringed plover *Charadrius dubius*

A regular winter visitor. A few hundreds arrive soon after the commencement of the Northeast monsoon in October and leave in March and April depending on the water condition. It was mostly seen along the freshwater pools. Seldom seen in brackish and coastal habitats.

Kentish plover *Charadrius alexandrinus*

Two races were found. The nominate *alexandrinus* is migratory arriving in several hundreds in September and departing between late February and mid March. None of them remained during the summer. The race *seebohmi* is a breeding resident and their numbers were augmented by local migrants during winter. The breeding season is between April and July. Maximum birds were counted (850) in January and February during spring passage of the nominate race.

Ringed plover *Charadrius hiaticula*

Rare. One was caught and ringed. None were sighted in the field.

Lesser sand plover *Charadrius mongolus*

One of the abundant winter visitors, which arrive from late August to mid October and depart between March and April. Maximum numbers were observed both in autumn and spring on passage. Several thousands were seen throughout the winter. Occurred in thousands in all the habitats depending upon the water conditions. A few hundreds, mostly first year birds, summered in all the habitats subject to the availability of water. The oversummering adults were seen in partial breeding plumage. Maximum number counted was 14,000 during October 1985.

Whimbrel *Numenius phaeopus*

A regular winter visitor in small numbers, seen in considerable number during the autumn passage in September and early October. A few first year birds oversummered in the Manali and Hare islands. A maximum of 186 birds were counted during September 1986.

Curlew *Numenius arquata*

A regular and common winter visitor in a few hundreds. Arrives in September and leaves in March. Some individuals (25-30) summered at Manali and Hare islands, but were seldom seen in other areas during the summer. The maximum recorded was 443 in October 1986.

Bartailed godwit *Limosa lapponica*

A common winter visitor. Arrives in a few hundreds by the middle of September and leaves by March. In addition to the wintering population, passage migrants are also seen on their autumn and spring passages. The maximum number recorded was 360 in September 1985. A few first year birds summered in Manali island. Distributed in all the study areas, during the month of September and October, and mainly confined to the eastern sandy area of Dhanuskodi lagoon during February and March.

Redshank *Tringa totanus*

A common winter visitor occurring in several hundreds between September and January in all the habitats. As the majority of the birds departed by February, their numbers fell after February. The highest number of wintering birds was 730 in 1985-86. This species could be seen throughout the year as some individuals summered on the island and other habitats subject to the water condition.

Marsh sandpiper *Tringa stagnatilis*

A common winter visitor in a few hundreds between late October and March. None in summer. Recorded mostly in the western part of Dhanuskodi and Pillaimadam lagoon. Not recorded from Manali and Hare islands.

Greenshank *Tringa nebularia*

A regular and common winter visitor arriving in several hundreds in early September and departing in late March or early April. Many young birds spent two seasons at Mandapam prior to returning to their breeding ground. A few adults were also found to oversummer. Seen in all the habitats in considerable numbers. The maximum number wintered in the year 1985-86.

Wood or Spotted sandpiper *Tringa glareola*

A regular winter visitor in small numbers arriving late October and departing late March or early April when the freshwater pools dry up. Not recorded from the exclusively marine habitat such as the Manali and Hare islands and the eastern part of the Dhanuskodi lagoon.

Terek sandpiper *Tringa terek*

A regular and common winter visitor arriving between late August and September in a few hundreds which stay throughout the winter. The occurrence of transient population in the autumn makes for a maximum population in September. Over 500 individuals wintered in the 1987-88 season. Summering first year birds were seen in all the summers at Manali and Hare islands. Though recorded in all the habitats they preferred Manali island and Kundugal Point.

Common sandpiper *Tringa hypoleucos*

A regular winter visitor but in small numbers between September and April. There is no record of this bird after April. The wintering population of 124 observed in the 1987-88 season was the maximum recorded during the three year study.

Spotted redshank *Tringa erythropus*

Rare. A single sighting record at Pillaimadam lagoon was the only record during the three year study.

Turnstone *Arenaria interpres*

A common and regular winter visitor. Seen in maximum numbers during the autumn passage between September and October. Though the majority depart in April for the breeding ground, a few birds remain on the two islands and along the beaches during summer. Occur at all study sites but preferred Manali and Hare islands and the eastern end of Dhanuskodi lagoon. Over 600 individuals were counted in 1985-86 and 1987-88.

Knot *Calidris canuta*

A regular winter visitor, a few hundreds arriving by the middle of October and departing in late March. None oversummered. The maximum numbers were observed in November and February. Seen only along the sandy intertidal areas of Kundugal Point, Manali island and the eastern end of Dhanuskodi.

Eastern knot *Calidris tenuirostris*

A regular winter visitor like the Knot, arriving and departing at the same time. The distribution pattern was also same as that of the knot. The wintering population was over 300 individuals. None of them oversummered.

Sanderling *Calidris alba*

As mentioned by Biddulph (1938), several hundred sanderlings winter in Dhanuskodi and Manali island. They arrive in early September and depart in late March and early April. A few individuals in non-breeding plumage were observed during the summer at Dhanuskodi. The maximum wintering population (850) was recorded during 1986-87. Largely confined to the eastern side of Dhanuskodi, Manali and Kundugal Point where the terrain is sandy.

Little stint *Calidris minuta*

An abundant winter visitor arriving in thousands during September and departing in March and April. None of them stayed back for the summer. Abundantly seen in Pillaimadam lagoon and the western part of Dhanuskodi lagoon. Occurred in thousands throughout the winter and the number fluctuated depending upon the water condition.

Curlew Sandpiper *Calidris testacea*

An abundant winter visitor arriving between September and October and departing between March and early April. Distribution pattern, population fluctuation, and habitat preference was almost the same as that of the Little stint but a portion of the population mostly "first year" birds oversummered in the two islands. Over 10,000 was observed to winter in the 1985-86 season.

Dunlin *Calidris alpina*

This species was not encountered in the field, perhaps from its close similarity to the Curlew sandpiper, but possibly from its rareness. However, 14 individuals were caught during the three year study.

Rednecked stint *Calidris ruficollis*

None were observed in the field. However, 12 individuals were caught and ringed during the three year study. An uncommon winter visitor to this site.

Temminck's stint *Calidris temminckii*

Only one sighting in the field indicating its rareness.

Longtoed stint *Calidris subminuta*

Like Temminck's stint, few sightings were recorded for this species. One bird was caught and ringed.

Broadbilled sandpiper *Limicola falcinellus*

A rare wintering wader at Mandapam. Few sightings, mainly of two to three individuals. In one instance at Manali island, 44 birds were seen in October during autumn passage.

Rednecked phalarope *Phalaropus lobatus*

A rare winter visitor, rarely sighted . Once 7 individuals were seen together at the Pillaimadam lagoon.

Pintail snipe *Gallinago stenura*

An uncommon winter visitor occurring on the grassy patches around fresh water pools.

Green sandpiper *Tringa ochropus*

An uncommon winter visitor to small fresh water ditches. The maximum number counted was 25 from all the study sites.

Blackwinged stilt *Himantopus himantopus*

A common, regular winter visitor in several hundreds. A few hundreds were seen throughout the summer in the freshwater pools in the Rameswaram island and other places around Mandapam. It was seen throughout the winter in the seawater inundated lagoons inside Hare island and the Pillaimadam lagoon. Avoids sandy areas. Not recorded from Manali and Dhanuskodi.

Great stone plover *Esacus magnirostris*

A breeding resident present throughout the year in small numbers, seventeen pairs were counted in the study areas.

Stone curlew *Burhinus oedicnemus*

Status unknown, being a crepuscular species. Its occurrence in large numbers during winter was noted from its call. Two birds were caught and ringed.

Crab plover *Dromas ardeola*

A fairly common winter visitor. Starts arriving in hundreds in September and October. Maximum numbers were observed during autumn passage in October. Present mainly in the intertidal area of Manali island. Considerable numbers were also noticed at Kundugal Point and Hare island. Not recorded from Dhanuskodi and Pillaimadam lagoon. A few individuals (10-20) mostly the first year birds summer in Manali island.

Redwattled lapwing *Vanellus indicus*

A breeding resident occurring in small numbers, mostly along the grassy patches of Pillaimadam lagoon.

Yellow-wattled lapwing *Vanellus malabaricus*

A breeding resident occurring in small numbers along with the Redwattled lapwing in the Pillaimadam lagoon and grassy patches near freshwater pools.

Herring gull *Larus argentatus*

A winter visitor in considerable numbers. Arrives in November and winters till April. Mostly found along the Pillaimadam lagoon and Manali island. Maximum population wintered during 1986-87.

Great blackheaded gull *Larus ichthyaetus*

A winter visitor. Arrives in November in small numbers, seen with the Herring gull at Pillaimadam lagoon and Manali island. Maximum number counted was 85 during 1985-86.

Great blackbacked gull *Larus fuscus*

A regular winter visitor in small numbers, seen only on Manali island. Arrive in late October and depart in April. Maximum number (64) was recorded during 1987-88.

Brownheaded gull *Larus brunnicephalus*

A fairly common winter visitor in several hundreds between October and April. A few individuals were seen till May. Recorded in all the study sites. Majority of them were seen at Dhanuskodi. The maximum number counted was 600.

Blackheaded gull *Larus ridibundus*

A common winter visitor in small numbers and recorded from all the habitats. Occurs between November and March. Maximum number of 85 birds were recorded during 1985-86.

Whiskered tern *Chlidonias hybrida*

A common winter visitor in a few hundreds. Some individuals were seen throughout the year. Recorded from all the habitats. The maximum number was recorded during February and March.

Gullbilled tern *Gelochelidon nilotica*

A common winter visitor in small numbers. Recorded from all the habitats in the study area. A few individuals were seen throughout the summer also. The maximum number of 136 was counted in October 1985

Caspian tern *Hydroprogne caspia*

A regular winter in small numbers (50-85). Recorded in all the study sites. A few individuals oversummered on Manali island.

Common tern *Sterna hirundo*

A regular winter visitor. Arrives in small numbers, between October and April, without much fluctuation in population. A few birds were sighted during summer, especially on the islands.

Little tern *Sterna albifrons*

A common breeding resident found in all the habitats. Their numbers were augmented in the winter by non-breeding migrants from other regions. The breeding season is from April to July.

Lesser crested tern *Sterna bengalensis*

One of the abundant winter visitors to this area. The maximum numbers were recorded during their autumn passage in October. A portion of the population breeding on the islets of Adam's bridge between Dhanuskodi and Mannar island of Sri Lanka. The maximum number was recorded during October 1985. Seen in all the study sites, but the largest number were counted from Manali island. The breeding season is between May and July.

Ducks, teals and geese

Three species of ducks (Pintail *Anas acuta,* Wigeon *A. penelope,* Shoveller *A. clypeata*), two species of teals (Common Teal *A. crecca,* Garganey *A. querquedula*) and the Barheaded Goose *Anser indicus* were recorded during the study period.

The commonest species is the Pintail (> 1000) followed by Garganey (> 500). Common Teal, Wigeon and Shoveller were observed in numbers between 200-400. Twenty eight Barheaded Geese were seen at the pillaimadam lagoon once.

Ducks arrive in November and stay till April depending upon the water conditions.

Egrets and herons

The local migrants like egrets (Little Egret *Egretta garzetta,* Cattle Egret *Bubulcus ibis,* Large Egret *Ardea alba*) and heron (Grey Heron *Ardea cinerea,* Pond Heron *Ardeola grayii,* Reef Heron *Egretta gularis* and Little Green Heron *Ardeola striatus*) were seen throughout the season. Their number fluctuated due to local movement subject to the water conditions. The population in the two islands were almost stable throughout the year, but at Dhanuskodi and Pillaimadam lagoons their numbers (especially Little Egret) went up to more than a thousand during March and April when the lagoons were drying. Little Green Heron and Reef Heron were rare among this group.

Discussion

Mandapam and its neighbouring islands are important coastal habitats for both passage and wintering migrant waterbirds, especially for the sand-flat preferring waders, maritime terns and flamingos. It supports a waterbird population of over 50,000 including resident and migrant species.

Though this area supports relatively lesser number of waders other than well known wader habitats such as Chilka Lake, Pulicat Lake and Great Vedaranyam Swamp. This is the only known habitat, along the east coast of India to support the uncommon sand-flat preferring species, namely Crab Plover, Sanderling, Knot, Eastern Knot and Bartailed Godwit in considerable numbers.

Alternatively exposed and submerged intertidal areas in the islands (due to daily tidal impacts), offer favourable feeding and roosting sites for the wintering and summering birds throughout the year. The huge congregation of passage and wintering migrants makes almost all the habitats sustain a dense wintering population during September and October. The highest density was seen on Manali island due to the occurrence of large number of birds within a small intertidal area of *c.* 1.5 sq. km. However, the Dhanuskodi lagoon supports a numerically large population of waders throughout winter except for two months.

Status of coastal birds: Among the waders the Lesser Sand Plover, Curlew-Sandpiper and Little Stint are most abundant. Ali and Ripley (1983) stated that Lesser Sand Plovers were more abundant, whereas the other two species were recorded as common winter visitors. However, this study shows that Curlew-Sandpiper and Little Stint are also among the abundant winter visitors to India. The status of the Knot is established as a regular winter visitor to India in small numbers, and the species is not a straggler as reported previously. Some of the uncommon waders to India such as Eastern Knot, Curlew and Whimbrel were found to be regular winter visitors at Mandapam. The occurrence of Crab Plovers in hundreds indicated that the two islands (Manali and Hare) in the Gulf of Mannar are important habitats next only to Piroten Islands in Kutch (coastal north-west India) where two to three thousand of them were reported to winter regularly (Hussain and Natarajan, Pers. comm.).

The Bar-tailed Godwit, reportedly a straggler in south India, was recorded in hundreds. The status of Sanderling was confirmed as a regular common winter visitor as stated by Biddulph (1938).

The marine terns, such as Lesser Crested and Sandwich Terns commonly occurred in the study area. The Lesser Crested Tern was reported to breed in the islets of Adam's bridge, and this fact has been confirmed by the present study. The other breeding species at Mandapam are: Little Tern, Kentish Plover, Stone Plover *Esacus magnirostris* and Stone Curlew *Burhinus oedicnemus*. Since flamingos frequent this area in several thousands, this is the third important wintering ground for flamingos along the east coast, next to Pulicat Lake and Great Vedaranyam Swamp. The rare waders to this area are the Broadbilled Sandpiper, Dunlin, Rednecked Phalarope, Longtoed and Temminck's Stint.

Passage and wintering migrants: Though individuals of most of the wader species stayed here throughout the winter season, some species occurred only as autumn passage migrants. The Black-tailed Godwit and Broad-billed Sandpiper are the two passage migrants, occurring only in October in low numbers. The other wintering migrants which occurred in relatively larger numbers, during their autumn passage, are Crab Plover, Grey Plover, Large Sand Plover, Whimbrel, Bar-tailed Godwit, Terek Sandpiper, Oystercatcher and Lesser Crested Tern. The only species occurring in larger numbers during spring passage was the Kentish Plover. The species occurring in maximum numbers both in autumn and spring passages are Knot, Eastern Knot, Sanderling, Eastern Golden Plover. Generally most of the migrant species were found in maximum numbers during earlier part of September and October, while a few species in peak numbers occurred during spring passage (February and March).

Summering migrants: Individuals of 15 species of migratory waders and 8 species of migratory terns were found to oversummer especially on the two islands. Individuals of these 23 species of migrants could thus be recorded throughout the year.

Arrival and departure dates: The migrants started arriving in late August. Most of the species arrived before the first week of October. The coastal species arriving after the first week of October were Knot, Eastern Knot, Marsh Sandpiper, Spotted Sandpiper, Green Sandpiper and Little Ringed Plover. The ducks, teals and flamingos and gulls arrived late in November.

Similarly, the departure time of migrants was generally from mid March to mid April. Some waders, such as Kentish Plover, Marsh Sandpiper, Terek Sandpiper and Bar-tailed Godwit departed during the last week of February, earlier than the other waders.

The species that departed very late were the Lesser Sand Plover, Curlew-Sandpiper, Sanderling, Grey Plover, Greenshank and Redshank. The departure time of fresh water species was solely dependent on the condition of freshwater pools, formed by rain water inundation. Similarly, water level in the Dhanuskodi lagoon was the prime factor determining departure period of flamingo.

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APPENDIX

CHECKLIST OF THE BIRDS OF MANDAPAM AND RAMESWARAM

	Common Name	Scientific Name		Common Name	Scientific Name
1.	Dabchick	*Tachybaptus ruficollis*	53.	Blackwinged Stilt	*Himantopus himantopus*
2.	Wilson's Storm Petrel	*Oceanites oceanicus*	54.	Crab plover	*Dromas ardeola*
3.	White Tropic-bird	*Phaethon lepturus*	55.	Stone Curlew	*Burhinus oedicnemus*
4.	Grey or Spottedbilled Pelican	*Pelecanus philippensis*	56.	Great stone Plover	*Esacus magnirostris*
5.	Large Cormorant	*Phalacrocorax carbo*	57.	Redwattled Lapwing	*Vanellus indicus*
6.	Little Cormorant	*Phalacrocorax niger*	58.	Yellow-wattled Lawping	*Vanellus malabaricus*
7.	Grey Heron	*Ardea cinerea*	59.	Grey Plover	*Pluvialis squatarola*
8.	Large Egret	*Ardea alba*	60.	Eastern Golden Plover	*Pluvialis dominica*
9.	Little Green Heron	*Ardeola striatus*	61.	Large Sand Plover	*Charadrius leschenaultii*
10.	Pond Heron	*Ardeola grayii*	62.	Ringed Plover	*Charadrius hiaticula*
11.	Cattle Egret	*Bubulcus ibis*	63.	Little Ringed Plover	*Charadrius dubius*
12.	Smaller or Median Egret	*Egretta intermedia*	64.	Kentish Plover	*Charadrius alexandrinus*
13.	Little Egret	*Egretta garzetta*	65.	Lesser Sand Plover	*Charadrius mongolus*
14.	Indian Reef Heron	*Egretta gularis*	66.	Whimbrel	*Numenius phaeopus*
15.	Night Heron	*Nycticorax nycticorax*	67.	Curlew	*Numenius arquata*
16.	Black Bittern	*Ixobrychus flavicollis*	68.	Blacktailed Godwit	*Limosa limosa*
17.	Painted stork	*Mycteria leucocephala*	69.	Bartailed Godwit	*Limosa lapponica*
18.	Openbill stork	*Anastomus oscitans*	70.	Common Redshank	*Tringa totanus*
19.	White Stork	*Ciconia ciconia*	71.	Marsh Sandpiper	*Tringa stagnatilis*
20.	White Ibis	*Threskiornis aethiopica*	72.	Greenshank	*Tringa nebularia*
21.	Black Ibis	*Pseudibis papillosa*	73.	Green Sandpiper	*Tringa ochropus*
22.	Spoonbill	*Platalea leucorodia*	74.	Wood or Spotted Sandpiper	*Tringa glareola*
23.	Flamingo	*Phoenicopterus roseus*	75.	Terek Sandpiper	*Tringa terek*
24.	Barheaded Goose	*Anser indicus*	76.	Common Sandpiper	*Tringa hypoleucos*
25.	Pintail	*Anas acuta*	77.	Turnstone	*Arenaria interpres*
26.	Common Teal	*Anas crecca*	78.	Pintail Snipe	*Gallinago stenura*
27.	Spotbill Duck	*Anas poecilorhyncha*	79.	Knot	*Calidris canuta*
28.	Wigeon	*Anas penelope*	80.	Eastern Knot	*Calidris tenuirostris*
29.	Garganey	*Anas querquedula*	81.	Sanderling	*Calidris alba*
30.	Shoveller	*Anas clypeata*	82.	Rednecked Stint	*Calidris ruficollis*
31.	Blackwinged Kite	*Elanus caeruleus*	83.	Little Stint	*Calidris minuta*
32.	Pariah Kite	*Milvus migrans*	84.	Temminck's Stint	*Calidris temminckii*
33.	Brahminy Kite	*Haliastur indus*	85.	Longtoed Stint	*Calidris subminuta*
34.	Shikra	*Accipiter badius*	86.	Dunlin	*Calidris alpina*
35.	Sparrow Hawk	*Accipiter nisus*	87.	Curlew Sandpiper	*Calidris testacea*
36.	White-eyed Buzzard Eagle	*Butastur teesa*	88.	Broadbilled Sandpiper	*Limicola falcinellus*
37.	Booted Hawk-Eagle	*Hieraaetus pennatus*	89.	Rednecked Phalarope	*Phalaropus lobatus*
38.	Whitebellied Sea Eagle	*Haliaeetus leucogaster*	90.	Skua	*Catharacta skua*
39.	Scavenger Vulture	*Neophron percnopterus*	91.	Herring Gull	*Larus argentatus*
40.	Pale Harrier	*Circus macrourus*	92.	Great Blackheaded Gull	*Larus ichthyaetus*
41.	Pied Harrier	*Circus melanoleucos*	93.	Brownheaded Gull	*Larus brunnicephalus*
42.	Marsh Harrier	*Circus aeruginosus*	94.	Blackheaded Gull	*Larus ridibundus*
43.	Short-toed Eagle	*Circaetus gallicus*	95.	Whiskered Tern	*Chlidonias hybrida*
44.	Crested Serpent Eagle	*Spilornis cheela*	96.	Gullbilled Tern	*Gelochelidon nilotica*
45.	Osprey	*Pandion haliaetus*	97.	Caspian Tern	*Hydroprogne caspia*
46.	Peregrine Falcon	*Falco peregrinus*	98.	Common Tern	*Sterna hirundo*
47.	Kestrel	*Falco tinnunculus*	99.	Little Tern	*Sterna albifrons*
48.	Grey Partridge	*Francolinus pondicerianus*	100.	Large Crested Tern	*Sterna bergii*
49.	Common Peafowl	*Pavo cristatus*	101.	Indian Lesser Crested Tern	*Sterna bengalensis*
50.	Ruddy Crake	*Porzana fusca*	102.	Sandwich Tern	*Sterna sandvicensis*
51.	Whitebreasted Waterhen	*Amaurornis phoenicurus*	103.	Noddy Tern	*Anous stolidus*
52.	Oystercatcher	*Haematopus ostralegus*	104.	Greyfronted Green Pigeon	*Treron pompadora*

Common Name	Species	Common Name	Species
105. Blue Rock Pigeon	*Columba livia*	147. Brahminy Myna	*Sturnus pogadarum*
106. Indian Ring Dove	*Streptopelia decaocto*	148. Rosy Pastor	*Sturnus roseus*
107. Indian Spotted Dove	*Streptopelia chinensis*	149. Common Myna	*Acridotheres tristis*
108. Roseringed Parakeet	*Psittacula krameri*	150. Indian Tree Pie	*Dendrocitta vagabunda*
109. Redwinged Crested Cuckoo	*Clamator coromandus*	151. House Crow	*Corvus splendens*
110. Pied Crested Cuckoo	*Clamator jacobinus*	152. Jungle Crow	*Corvus macrorhynchos*
111. Small Cuckoo	*Cuculus poliocephalus*	153. Common Wood Shrike	*Tephrodornis pondicerianus*
112. Common Hawk Cuckoo or Brain fever Bird	*Cuculus varius*	154. Blackheaded Cuckoo-Shrike	*Coracina melanoptera*
113. Indian Plaintive Cuckoo	*Cacomantis passerinus*	155. Common Iora	*Aegithina tiphia*
114. Indian Banded Bay Cuckoo	*Cacomantis sonneratii*	156. Redvented Bulbul	*Pycnonotus cafer*
115. Indian Drongo Cuckoo	*Surniculus lugubris*	157. Whitebrowed Bulbul	*Pycnonotus luteolus*
116. Koel	*Eudynamys scolopacea*	158. Common Babbler	*Turdoides caudatus*
117. Small Greenbilled Malkoha	*Rhopodytes viridirostris*	159. Whiteheaded Babbler	*Turdoides affinis*
118. Crow-pheasant	*Centropus sinensis*	160. Brown Flycatcher	*Muscicapa latirostris*
119. Spotted Owlet	*Athene brama*	161. Brownbreasted Flycatcher	*Muscicapa muttui*
120. Short-eared Owl	*Asio flammeus*	162. Bluethroated Flycatcher	*Muscicapa rubeculoides*
121. Common Nightjar	*Caprimulgus asiaticus*	163. Paradise Flycatcher	*Terpsiphone paradisi*
122. Alpine Swift	*Apus melba*	164. Tailor Bird	*Orthotomus sutorius*
123. Palm Swift	*Cypsiurus parvus*	165. Blyth's Reed Warbler	*Acrocephalus dumetorum*
124. Lesser Pied Kingfisher	*Ceryle rudis*	166. Paddyfield Warbler	*Acrocephalus agricola*
125. Common Kingfisher	*Alcedo atthis*	167. Lesser Whitethroat	*Sylvia curruca*
126. Whitebreasted Kingfisher	*Halcyon smyrnensis*	168. Largebilled Leaf Warbler	*Phylloscopus magnirostris*
127. Blackcapped Kingfisher	*Halcyon pileata*	169. Dull Green Leaf Warbler	*Phylloscopus trochiloides*
128. Bluetailed Bee-eater	*Merops philippinus*	170. Blue Chat	*Erithacus brunneus*
129. Green Bee-eater	*Merops orientalis*	171. Magpie-Robin	*Copsychus saularis*
130. Indian Roller or Blue Jay	*Coracias benghalensis*	172. Indian Robin	*Saxicoloides fulicata*
131. Hoopoe	*Upupa epops*	173. Pied Ground Thrush	*Zoothera wardii*
132. Lesser Goldenbacked Woodpecker	*Dinopium benghalense*	174. Orangeheaded Ground Thrush	*Zoothera citrina*
133. Indian Pitta	*Pitta brachyura*	175. Richard's Pipit	*Anthus novaeseelandiae richardi*
134. Bush Lark	*Mirafra assamica*		
135. Redwinged Bush Lark	*Mirafra erythroptera*	176. Paddyfield Pipit	*Anthus novaeseelandiae rufulus*
136. Ashycrowned Finch-Lark	*Eremopterix grisea*		
137. Eastern Skylark	*Alauda gulgula*	177. Forest Wagtail	*Motacilla indica*
138. Swallow	*Hirundo rustica*	178. Yellow Wagtail	*Motacilla flava*
139. Baybacked Shrike	*Lanius vittatus*	179. Grey Wagtail	*Motacilla cinerea*
140. Brown Shrike	*Lanius cristatus*	180. Large Pied Wagtail	*Motacilla maderaspatensis*
141. Golden Oriole	*Oriolus oriolus*	181. Tickell's Flowerpecker	*Dicaeum erythrorhynchos*
142. Black Drongo	*Dicrurus adsimilis*	182. Purplerumped Sunbird	*Nectarinia zeylonica*
143. Grey Drongo	*Dicrurus leucophaeus*	183. Purple Sunbird	*Nectarinia asiatica*
144. Ashy Swallow-Shrike	*Artamus fuscus*	184. House Sparrow	*Passer domesticus*
145. Greyheaded Myna	*Sturnus malabaricus malabaricus*	185. Yellowthroated Sparrow	*Petronia xanthocollis*
		186. Spotted Munia	*Lonchura punctulata*
146. Whiteheaded Myna	*Sturnus malabaricus blythii*	187. Blackheaded Munia	*Lonchura malacca*

CYTOLOGICAL INVESTIGATIONS ON THE ASTERACEAE-GENUS *BLUMEA* AND RELATED GENERA *LAGGERA* AND *NANOTHAMNUS*[1]

A.R. Daruwalla[2]

(*With three plates*)

Key words: *Blumea* spp., *Laggera* spp., *Nanothamnus* sp., cytological treatment

Meiotic chromosome numbers are reported for 20 species of *Blumea*, 3 species of *Laggera* and 1 species of *Nanothamnus* occurring in India. The counts have been made from a total of 250 specimens, with full voucher information for each. New data is compared with all previous reports for the species of these three genera. Some conclusions are drawn regarding the affinities of the species.

Introduction

The genus *Blumea* belongs to the Tribe Inuleae, Sub-tribe Plucheinae, of the family Asteraceae and forms a dominant element of the "weed floras" of SE. Asia. Many species of the genus are second growth plants occupying disturbed areas along roadsides, railway lines and forest paths, and in clearings, thickets and waste fields. A few species are shrubby and grow as undergrowth plants of evergreen forests at high altitudes. All species are tropical and restricted to the Old World.

Laggera is also a weedy genus distributed in India, tropical Asia and Africa. *Nanothamnus* is endemic, monotypic and restricted to a few localities in western peninsular India.

On the basis of previous taxonomic investigations (Randeria 1960), the genus *Blumea* has been divided into 7 sections containing a total of 49 species over the entire geographical range. These species have been delimited on the basis of traditional characters of habit and inflorescence type, as well as on the anatomy of leaf epidermal cells, position of stomata, and type of trichomes. This was necessary because the species of the genus are very closely inter-related and often subtly intergrade into one another through hybridization, back crossing and apomixis. The pattern of evolution is possibly a highly complex, three-dimensional reticulum. In general, *Blumea* appears to be a young genus rapidly evolving at the present time and also extending its geographic range. Because of these various problems, additional evidence from cytological investigations was needed to support the data from external and internal morphology.

It was with this view in mind that the present study was undertaken. The cytological investigations have been limited only to the Indian species of *Blumea, Laggera* and *Nanothamnus* because of the ready availability of the material. Of the total of 49 species of *Blumea*, 23 occur in India and they are distributed among 6 of the 7 sections of the genus. Material could only be collected for 19 of these species, and they have been investigated for their chromosome numbers. In addition, chromosome counts have also been obtained for *Laggera aurita* Sch.-Bip. and *Nanothamnus sericeus* T. Thoms.

Materials and Methods

Fresh materials of the various species of *Blumea, Laggera* and *Nanothamnus* were collected and included both capitula with unopened flower buds and mature achenes. The capitula were fixed in the field whereas the achenes were preserved for subsequent germination in the laboratory. The chromosome counts listed in this study were, however, exclusively made from meiotic divisions in the pollen mother cells because of the inability of getting the seeds to germinate even under varied conditions.

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[1] Accepted October 1993.

[2] Blatter Herbarium, St. Xavier's College, Bombay 400 001.

Collections were made over three successive growing seasons and in all some 250 specimens have been obtained. All these were subjected to cytological inquiry. Four other species of *Blumea,* namely, *Blumea aromatica* DC., *Blumea barbata* DC., *Blumea bifoliata* (Linn.) DC., and *Blumea napifolia* DC., have been reported as occurring in India. Material for the same could not be collected and hence, these have been excluded from the present cytological treatment.

Young capitula of various sizes with unopened florets were collected from the plant and immediately fixed in the field in Newcomer's solution (Newcomer 1953). The same specimen was later pressed and mounted for the herbarium.

The fixed material was brought to the laboratory and left to stand for at least 24 hours in order to allow for thorough penetration by the fixative. The material was then transferred to vials containing propionocarmine and stained for 24 hours. After this, the anthers were dissected out in a drop of stain on a slide and squashed by digital pressure. Slides were made permanent by immersing them in a solution containing one part glacial acetic acid and one part N-butyl alcohol till the slide and coverslip could be separated. Then, the slide and coverslip with the adhering material were passed through pure N-butyl alcohol for dehydration before mounting in Canada Balsam.

Karyotype drawings were made with a camera lucida from both temporary and permanent mounts; all illustrations are drawn to the same scale. Photographs have been made from permanent slides. Voucher specimens with karyotype diagrams and permanent slides have been deposited in the Blatter Herbarium, St. Xavier's College, Bombay.

All the Indian species of *Blumea* investigated cytologically are arranged under their respective sections. The treatment of each species includes the chromosome number and a list of specimens. Diagrams and photomicrographs of meiotic figures are provided for each species. The species of *Laggera* and *Nanothamnus* are similarly described.

Cytological History of Tribe Inuleae — Sub-tribe Plucheinae: The Plucheinae is one of the 8 subtribes of the Tribe Inuleae and includes a total of 18 genera (Hoffmann 1897). Ten genera have very restricted distribution and of these, 5 are endemic as well as monotypic. The remaining 8 genera have few to many species each and are widely distributed and abundant where they occur.

There is not much information regarding the cytology of the Plucheinae. Chromosome numbers have been reported for only 5 genera and, in each case, only a few species have been worked out.

The 5 genera are: *Pluchea* (8 species): $2n = 20$ or 30; *Pterocaulon* (1 species) : $2n = 20$; *Blumea* (14 species) : $2n = 18, 20,$ or 22; *Laggera* (4 species): $2n = 20$ or 22; *Sphaeranthus* (2 species) :$2n = 20$.

With regard to the other subtribes of the Inuleae, the following chromosome numbers have been reported:

Subtribe Tarchonanthinae — 3 genera — no reports.

Subtribe Filagininae — 12 genera.

Filago germanica: $2n = 28$.

Subtribe Gnaphalinae — 49 genera

Antenaria (7 species): $2n = 28, 42, 56$ or 84; *Leontopodium* (4 species): $2n = 20, 24$ or 52; *Anaphalis* (3 species) : $2n = 14$ or 28; *Gnaphalium* (6 species): $2n = 14, 28,$ or 56; *Helichrysum* (1 species): $2n = 28$.

Subtribe Angianthinae — 11 genera

Caesulia axillaris Roxb.: $2n = 14$.

Subtribe Relhaninae — 14 genera — no reports.

Subtribe Athrixinae — 7 genera — no reports.

Subtribe Inulinae — 22 genera

Inula (7 species): $2n = 16$ or 32;

Perralderia (1 species): $2n = 18$.

From the above rather inadequate data, it is difficult to draw any conclusions. However, it appears in general that 3 subtribes of the Inuleae, namely, Filagininae, Gnaphalinae and Angianthinae have a base number of $n = 7$. The Inulinae possibly have a base number of $n = 8$ or 9.

The existing records of the 5 genera of the Plucheinae, as well as this present study on the chromosome counts of *Blumea, Laggera* and *Nanothamnus* point towards a base number of $n = 9$, 10 or 11 for the subtribe.

The Inuleae thus appear to be a diverse and possibly polyphyletic group with the commonest basic chromosome numbers ranging from n = 7 to n = 11. Polyploid series exist for all these numbers though aneuploidy is not common.

These results conform with the work done on the chromosome numbers of other tribes of the Asteraceae. Extensive studies have been carried out on the Astereae and n = 9 is regarded as a basic number for that group with a second mode centering around n = 4 or 5. In general, the woody habit is primitive and the low chromosome number is a specialised condition correlated with dry habitat (Raven *et al.* 1960, 1964).

The Helenieae have the commonest basic numbers n = 6, 7, or 8, and the chromosome numbers coincide with morphological variability. It is not possible to arrive at a single basic number for this tribe (Raven and Kyhos 1961).

A base number of n = 10 has been proposed for the Senecioneae (Ornduff *et al.* 1963) and of n = 9 for the Ambrosineae (Payne *et al.* 1964).

Cytological Treatment:

A. **Blumea** DC.

The genus *Blumea* has been divided into 7 sections and 49 species (Randeria 1960). Of these, 6 sections including 23 species are represented in India. Section Sagittatae occurs only in China and Indochina.

Section I. Semivestitae

Total number of species — 8.

Species found in India — 3.

Species belonging to this section are predominantly shrubby. The capitula are paniculate with the outer phyllaries ovate to oblong. The receptacle is pubescent to fimbriate. Achenes are ribbed.

1. **Blumea procera** DC., Prodr. 5: 445. 1836.

Chromosome number: n = 10

Specimens examined: Assam, Shillong: *ARD 83, ARD 238, ARD 240, ARD 248* (BLAT).

2. **Blumea riparia** (Bl.) DC., Prodr. 5: 444. 1836.

var. *riparia* Randeria, Blumea 10 (1): 214. 1960.

Conyza riparia Blume, Bijdr. 899. 1826, *non* H.B.K.

Chromosome number: n = 10 (Previously reported - n = 9, Bhattarai, Gorkhali and Saiju from Nepal).

Specimens examined: Assam, Shillong: *ARD 84, ARD 239, ARD 250* (BLAT).

3. **Blumea lanceolaria** (Roxb.) Druce, Rep. Bot. Exch. Club Brit. Isles 4:609. 1917.

Conyza lanceolaria Roxb., Fl. Ind. 3: 432. 1832.

Chromosome number: n = 10 (Previously reported - n = 10, R.C. Gupta and B.S. Gill from Madhya Pradesh).

Specimens examined: N. Kanara, Castlerock: *ARD 109-112*; Jog Falls: *ARD 142, 143*; Sirsi: *ARD 146, 147, ARD 214* (BLAT).

Section II. Macrophyllae

Total number of species - 10.

Species found in India - 3.

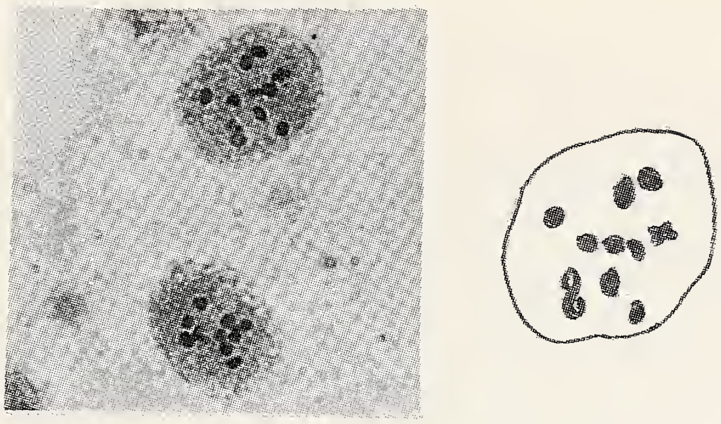
Species belonging to this section range from herbaceous to shrubby. The capitula are arranged in panicles and the outer phyllaries are linear. The receptacle may be glabrous, pilose or fimbrillate. Achenes are ribbed.

4. **Blumea aromatica** DC., Prodr. 5: 446. 1836.

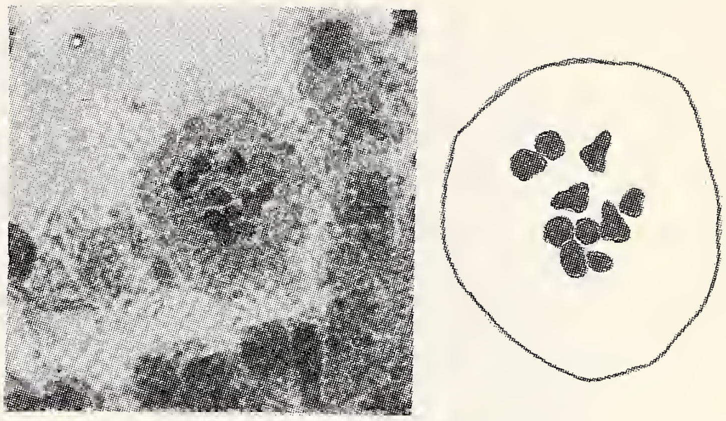
Chromosome number: This species was not examined cytologically as no material of the same was collected (Previously reported - 2n = 18, Malla, Bhattarai *et al.* from Nepal; 2n = 18, Ching-I Peng and Chien-Chang Hsu from Taiwan).

5. **Blumea densiflora** DC., Prodr. 5: 446. 1836.

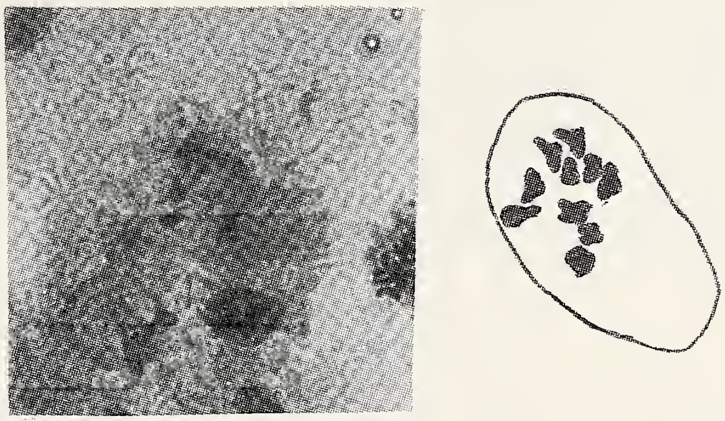
Chromosome number: No chromosome count could be made for this species because young flower buds could not be collected. The specimens



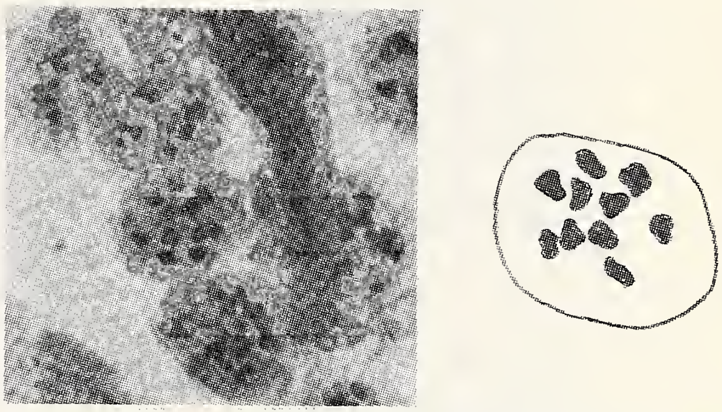
1. *Blumea procera* DC.
n = 10 (ARD 83)



2. *Blumea riparia* (Bl.) DC.
n = 10 (ARD 84)

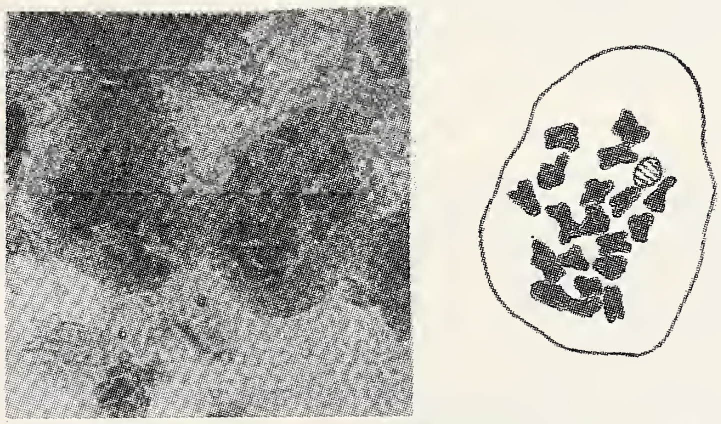


3. *Blumea lanceolaria* (Roxb.) Druce
n = 10 (ARD 110)

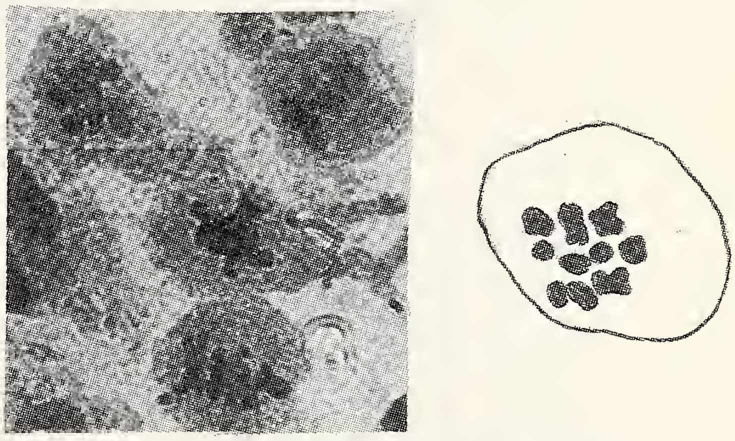


4. *Blumea balsamifera* (Linn.) DC.
n = 10 (ARD 228)

25 µ



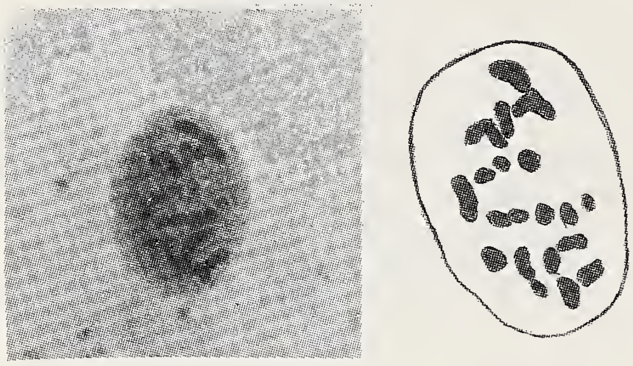
5. *Blumea hieraciifolia* (D.Don) DC.
var. *macrostachya* (DC.) Hook.f.
n = 18 (ARD 86)



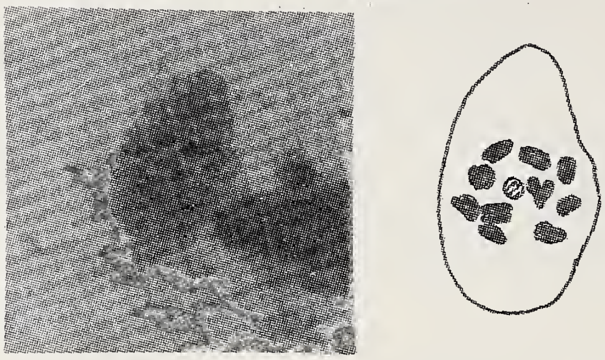
6. *Blumea clarkei* Hook.f.
n = 10 (ARD 151)

Photomicrographs and Karyotype Drawings.
1-3. Section Semivestitae; 4. Section Macrophyllae; 5-6. Section Hieraciifoliae.

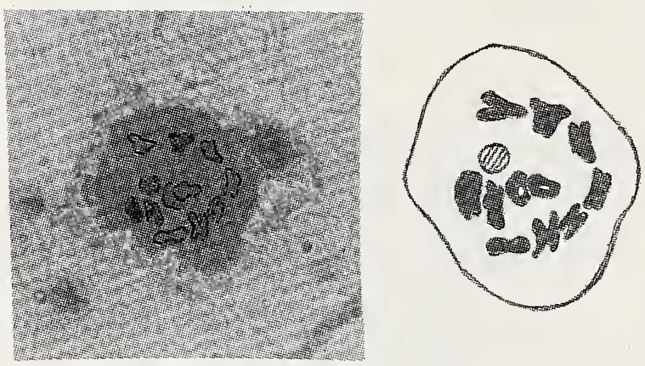
1. *Blumea fistulosa* (Roxb.) Kurz
n = 20 (ARD 164)



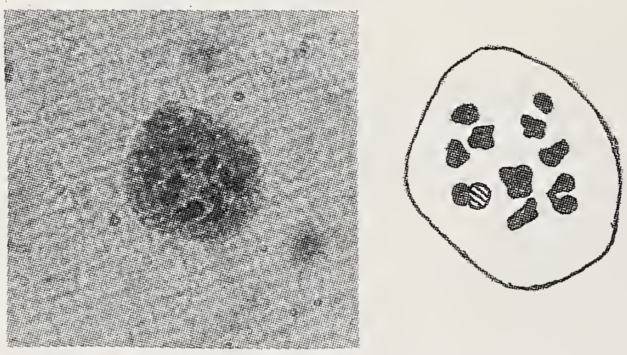
2. *Blumea sessiliflora* Decsne.
n = 10 (ARD 221)



3. *Blumea laciniata* (Roxb.) DC.
n = 11 (ARD 193)

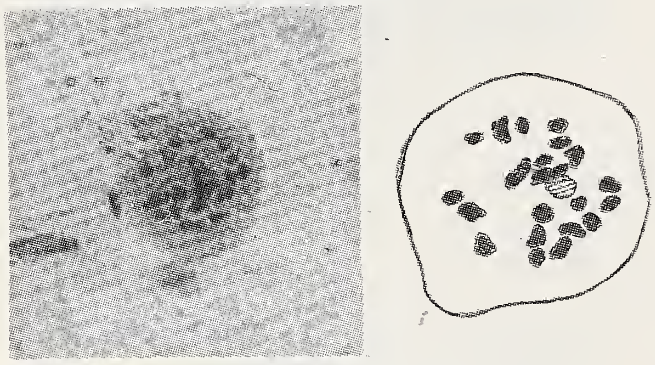


4. *Blumea mollis* (D.Don) Merr.
n = 11 (ARD 127)

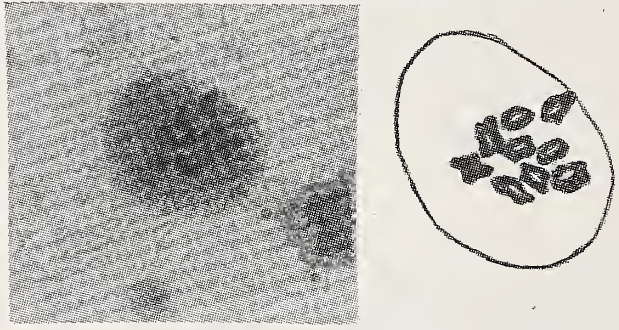


25μ

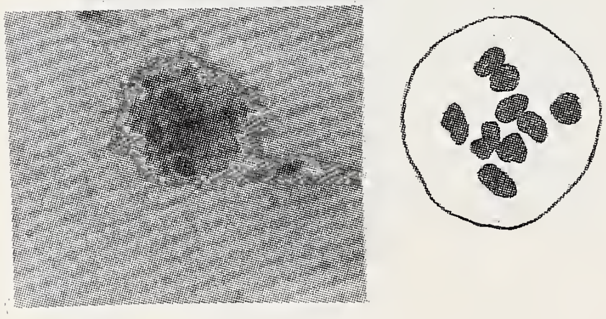
5. *Blumea lacera* (Burm.f.) DC.
n = 22 (ARD 71)



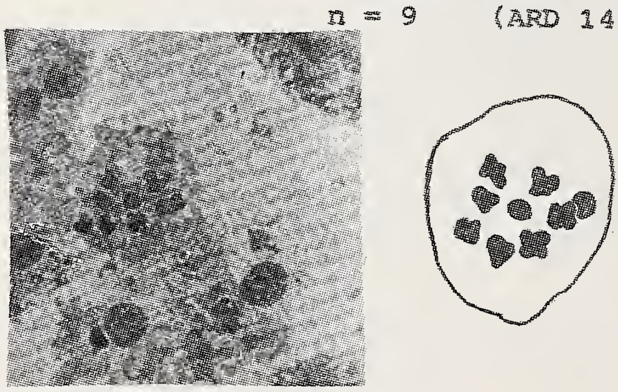
6. *Blumea membranacea* DC.
var. *membranacea* Rand.
n = 9 (ARD 71)



7. *Blumea membranacea* DC.
var. *jacquemontii* (Hk.f.) Rand.
n = 9 (ARD 99)



8. *Blumea virens* DC.
n = 9 (ARD 144)



Photomicrographs and Karyotype Drawings.
1-8. Section Paniculatae.

were collected mostly in fruit. There is no previous report of the chromosome number.

Specimens examined: Assam, Mowlai Forest Reserve: *ARD 241, ARD 247* (BLAT).

6. **Blumea balsamifera** (Linn.) DC., Prodr. 5: 447.1836.

Conyza balsamifera Linn. Sp. Pl. ed. 2: 1208. 1763.

Chromosome number: n = 10

Specimens examined: Assam, Shillong: *ARD 245 - 246*; Mowlai Forest Reserve: *ARD 249*. Nepal, Chatraghat: *ARD 227-228* (BLAT).

Section III. Sagittatae

This section contains one species, *Blumea sagittata* Gagnep., found only in China.

Section IV. Hieraciifoliae

Total number of species - 5.

Species found in India - 2.

Species belonging to this section are either herbs or subshrubs. The capitula occur in clusters. Phyllaries are linear-oblong. The receptacle is alveolate and glabrous or pilose. Achenes are ribbed.

7. **Blumea hieraciifolia** (D. Don) DC. *in* Wight, Contrib. Bot. Ind. 15. 1834.

Erigeron hieracifolium D. Don, Prodr. Fl. Nep. 272. 1825.

This species has four varieties, three of which occur in India - var. *hieraciifolia*, var. *macrostachya*, and var. *hamiltoni*. The chromosome number has been worked out for only one of these varieties.

var. **macrostachya** (DC.) Hook.f., Fl. Brit. India 3: 263. 1882.

Chromosome number: n = 18 (Previously reported - 2n = 48, Ching-I Peng and Chien-Chang Hsu from Taiwan).

Specimens examined: Assam, Shillong: *ARD 238, ARD 240 - 241, ARD 247 - 248* (BLAT).

8. **Blumea clarkei** Hook.f., Fl. Brit. India 3: 267. 1882.

Chromosome number: n = 10

Specimens examined: N. Kanara: *ARD 151-153, ARD 215-220* (BLAT).

Section V. Paniculatae

Total number of species - 11.

Species found in India - 9.

Species belonging to this section are herbs. Capitula occur in panicles or glomerules. Phyllaries are linear. The receptacle is alveolate and glabrous or pubescent. Achenes may or may not be ribbed.

9. **Blumea fistulosa** (Roxb.) Kurz, Jour. As. Soc. Bengal 46 (2): 187. 1877.

Conyza fistulosa Roxb., Fl. Ind. 3: 429. 1832.

Chromosome number: n = 20 (Previously reported - 2n = 30, R.C. Gupta and B.S. Gill from Madhya Pradesh; n = 9, Abraham Mathew and P.M. Mathew from Kerala).

Specimens examined: Madhya Pradesh, Umaria-Khappa: *ARD 162 - 166*. East Nepal: *ARD 229-230* (BLAT)

10. **Blumea sessiliflora** Decaisne, Nouv. Ann. Mus. Par. 3: 140. 1834.

Chromosome number: n = 10

Specimens examined : Karnataka, Castlerock and N. Kanara: *ARD 113, ARD 123-124, ARD 211-212, ARD 221* (BLAT).

11. **Blumea laciniata** (Roxb.) DC., Prodr. 5: 436. 1836.

Conyza laciniata Roxb., Fl. Ind. 3: 428. 1832.

Chromosome number: n = 11 (Previously reported - n = 11, Remananden from West Himalayas, 2n = 18, Ching-I Peng and Chien-Chang Hsu from Taiwan).

Specimens examined: Assam, Shillong: *ARD 242, ARD 244*. Gujarat, Dahanu: *ARD 190-196*. Karnataka, N. Kanara: *ARD 159-160*. E. Nepal: *ARD 232* (BLAT).

12. **Blumea mollis** (D. Don) Merr., Philipp. Jour. Sci. (Bot.) 5: 395. 1910.

Erigeron molle D. Don, Prodr. Fl. Nep. 172. 1825.

Chromosome number: n = 10 or 11 (Previously reported - n = 11, Remananden from Nilgiri Hills; n = 11, L.S. Gill and A.M. Abubakar from Tanzania; n = 9 + 1-2, Abraham Mathew and P.M. Mathew from Kerala).

Specimens examined: Maharashtra, Bombay: *ARD 14-15, ARD 68-69, ARD 200*; Khandala: *ARD 45*; Koyna: *ARD 24*; Mahableshwar: *ARD 64*; Matheran: *ARD 31, ARD 71.* Karnataka, Belgaum: *ARD 135*; Castlerock: *ARD 226.* Gujarat, Baroda: *ARD 104-106;* Dahanu: *ARD 187-188.* Madhya Pradesh, Nagpur: *ARD 170, ARD 172* (BLAT).

13. **Blumea lacera** (Burm.f.) DC. *in* Wight, Contrib. Bot. Ind. 14. 1834.

Conyza lacera Burm.f., Fl. Ind. 180, t. 59, f. 1. 1768.

Chromosome number: n = 22 (Previously reported - n = 9, Patil and Kamble from W. Bengal; 2n = 36, Ching-I Peng and Chien-Chang Hsu from Taiwan).

Specimens examined: Maharashtra, Lonavla: *ARD 81.* Karnataka, Castlerock: *ARD 117-122, ARD 129, ARD 138, ARD 222.* Gujarat, Dangs: *ARD 178-179.* Nepal: *ARD 223-224, ARD 235-237* (BLAT)

14. **Blumea membranacea** DC., Prodr. 5: 440. 1836.

Conyza membranacea Wall., Cat. no. 3019, comp. no. 129. 1831 *n.n.*

Chromosome number: n = 9

(Previously reported - n = 22, Remananden from Kerala; 2n=18, Abraham Mathew and P.M. Mathew from Tamil Nadu).

Specimens examined: Maharashtra, Borivli National Park: *ARD 17*; Elephanta Island: *ARD 35-37*; Khandala: *ARD 49*; Lonavla: *ARD 79*; Mahableshwar: *ARD 29*, ARD 63; Matheran: *ARD 32, ARD 71.* Madhya Pradesh, Nagpur: *ARD 171, ARD 173*; Tamia: *ARD 154-155, ARD 158* (BLAT).

var. **jacquemontii** (Hook.f.) Randeria, Blumea 10 (1): 271. 1960.

Blumea jacquemontii Hook.f., Fl. Brit. India 3: 265. 1882.

Chromosome number: n = 9

Specimens examined: Rajasthan, Mount Abu: *ARD 91-99* (BLAT).

15. **Blumea virens** DC. *in* Wight, Contrib. Bot. Ind. 14. 1834.

Conyza virens Wall., Cat. no. 3037, comp. no. 147. 1831 *n.n.*

Chromosome number: n = 9

Specimens examined: Karnataka, Castlerock: *ARD 125-126*; N. Kanara: *ARD 139-140, ARD 144-145, ARD 148-150* (BLAT).

Section VI. Oxyodontae

Total number of species - 4.

Species found in India - 4.

Species belonging to this section are pubescent herbs which may be erect or prostrate. Capitula are arranged in axillary and terminal clusters or panicles. Outer phyllaries are linear. The receptacle is glabrous and alveolate. Achenes are not ribbed.

16. **Blumea belangeriana** DC., Prodr. 5: 444. 1836.

Chromosome number: n = 10

Specimens examined: Gujarat, Dangs: *ARD 181*; Junagadh: *ARD 66.* Karnataka, Castlerock: *ARD 128*; Jog Falls: *ARD 141.* Maharashtra, Khandala: *ARD 48*; Matheran: *ARD 30, ARD 72, ARD 75* (BLAT).

17. **Blumea malcolmii** (Clarke) Hook.f., Fl. Brit. India 3: 266. 1882.

Pluchea malcolmii Clarke, Comp. Ind. 95. 1876.

Chromosome number: Only one specimen was collected and no count could be made. (Previously reported - 2n=18, Abraham Mathew and P.M. Mathew from Kerala).

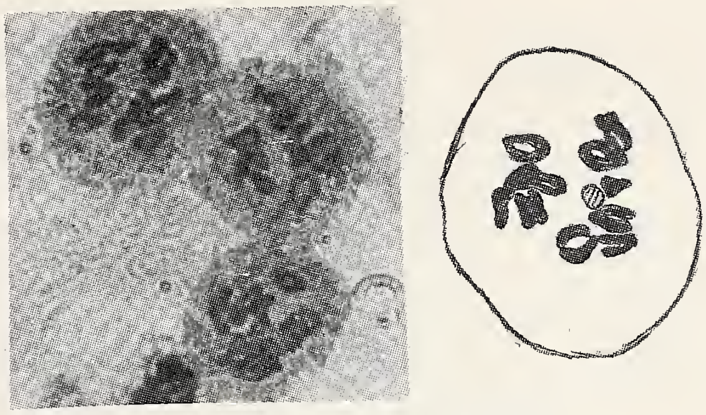
Specimen examined: Maharashtra, Mahableshwar: *ARD 28* (BLAT).

18. **Blumea eriantha** DC. *in* Wight, Contrib. Bot. Ind. 15. 1834.

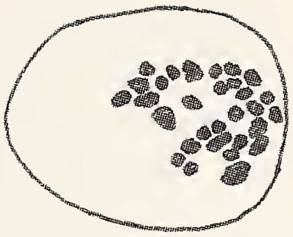
Chromosome number: n = 30 (Previously reported - 2n = 20, Amthul Shukur, K.N. Narayan and C. Shantamma from Karnataka).

Specimens examined: Include both fertile plants with well-developed anthers and sterile ones with abortive anthers.

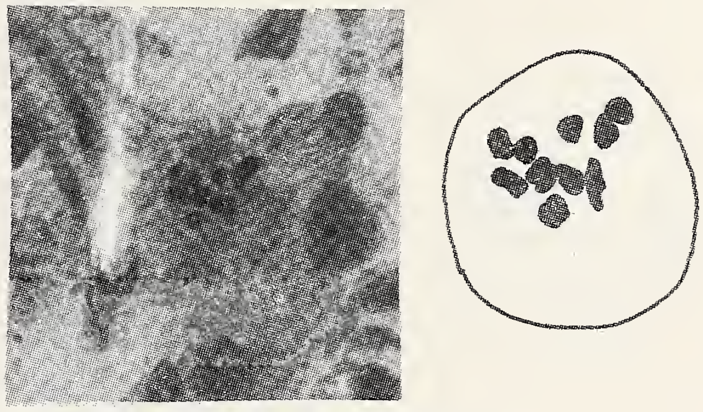
Fertile: Gujarat, Baroda: *ARD 185.* Maharashtra, Bombay: *ARD 5-6*; Lonavla: *ARD 80*; Mahableshwar *ARD 50-51, ARD 62, ARD 65, ARD 202-204*; Matheran: *ARD 33, ARD 70, ARD 82*; Nagpur: *ARD 176* (BLAT).



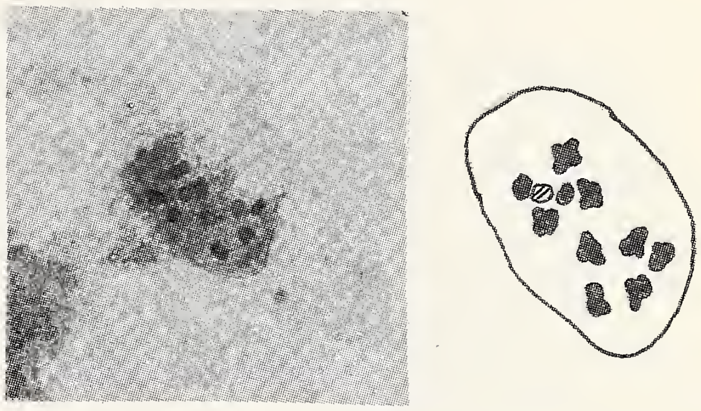
1. Blumea belangeriana DC.
n = 10 (ARD 181)



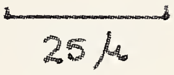
2. Blumea eriantha DC.
n = 30 (ARD 202)

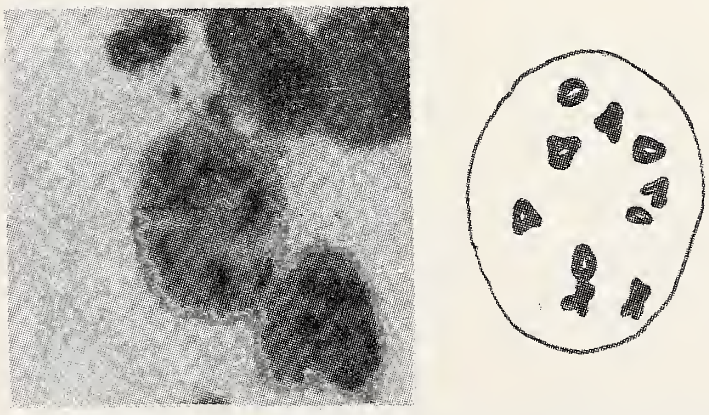


3. Blumea oxyodonta DC.
n = 10 (ARD 202)

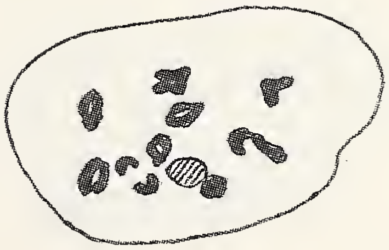


4. Blumea obliqua (Linn.) Druce
n = 10 (ARD 183)





5. Laggera aurita (Linn.f.) Sch.-Bip.
n = 10 (ARD 132)



6. Nanothamnus sericeus T.Thoms
n = 10 (ARD 197)

Photomicrographs and Karyotype Drawings.
1-3. Section Oxyodontae; 4. Section Dissitiflorae; 5. *Laggera*; 6. *Nanothamnus*.

Sterile: Gujarat, Baroda: *ARD 103, ARD 107*; Dangs: *ARD 180.* Karnataka, Belgaum: *ARD 134*; Castlerock: *ARD 114-116, ARD 213.* Maharashtra, Bombay: *ARD 18-19, ARD 21*; Dahanu: *ARD 189;* Khandala: *ARD 43*; Mahableshwar: *ARD 54-57, ARD 59*; Nagpur: *ARD 174*; Tansa: *ARD 201* (BLAT).

19. **Blumea oxyodonta** DC. *in* Wight, Contrib. Bot. Ind. 15. 1934.

Chromosome number: n = 10

Specimens examined: Both sterile and fertile collections were obtained, often from the same locality, as in the previous species.

Fertile: Gujarat, Dangs: *ARD 177.* Maharashtra, Khandala: *ARD 44*; Koyna: *ARD 26*; Lonavla: *ARD 78*; Mahableshwar: *ARD 51, ARD 53, ARD 55, ARD 60-61*; Matheran: *ARD 76* (BLAT).

Sterile: Karnataka, Belgaum: *ARD 136-137.* Maharashtra, Bombay: *ARD 1-4, ARD 7-10, ARD 13, ARD 16*; Khandala: *ARD 42, ARD 46*; Koyna: *ARD 22-23, ARD 25*; Lonavla: *ARD 77*; Mahableshwar: *ARD 27, ARD 58*; Matheran: *ARD 74*; Tansa: *ARD 199* (BLAT).

Section VII. Dissitiflorae

Total number of species - 10.

Species found in India - 2.

Species belonging to this section are slender herbs. Capitula are either solitary or in lax, few-headed panicles. Outer phyllaries are linear. The receptacle is areolate and glabrous. Achenes may or may not be ribbed.

20. **Blumea obliqua** (Linn.) Druce, Rep. Bot. Exch. Club Brit. Isles 4: 609. 1916 (1917).

Erigeron obliquum Linn. Mant. 2: 573. 1771.

Chromosome number : n = 10 (Previously reported - n = 10, Bhandari and Singhvi from Rajasthan; 2n = 20, Amthul Shakur *et al.* from Tamil Nadu).

Specimens examined: Gujarat, Baroda: *ARD 108*; Dangs: *ARD 182-183* (BLAT).

21. **Blumea bifoliata** (Linn.) DC. *in* Wight, Contrib. Bot. Ind. 14. 1834.

Conyza bifoliata Linn. Sp. Pl. 1207. 1753.

Chromosome number: Not determined, since no specimens could be collected (Previously reported - n = 18, Abraham Mathew and P.M. Mathew from Kerala; 2n = 20, Amthul Shakur *et al.* from Karnataka).

B. **Laggera** Sch.-Bip.

This is a tropical genus with about 10 species (Hooker 1882) distributed in Africa and India. It is distinguished from *Blumea* by having decurrent leaves and anthers without tail-like appendages. Six species occur in India (Clarke 1876), of which two have been collected and subjected to cytological inquiry.

1. **Laggera alata** (D.Don) Sch.-Bip. *ex* Oliver *in* Trans. Linn. Soc. 29: 94. 1873.

Erigeron alatum D. Don, Prodr. Fl. Nep. 171. 1825.

Chromosome number: Could not be determined since only one specimen was collected (Previously reported - n = 10, Subramaniam and Kamble from Tamil Nadu).

Specimens examined: Gujarat, Junagadh: *ARD 67* (BLAT).

2. **Laggera aurita** (Linn.f.) Sch.-Bip. *in* Schweinf. Beitr. Fl. Aethiop. 151. 1867.

Conyza aurita Linn.f., Suppl. 367. 1781.

Chromosome number: n = 10 (Previously reported - n = 10, Abraham Mathew and P.M. Mathew from Tamil Nadu; n = 11, L.S. Gill and A.M. Abubakar from Tanzania).

Specimens examined: Gujarat, Baroda: *ARD 87-90, ARD 100-102, ARD 186*; Broach: *ARD 184.* Karnataka, Belgaum: *ARD 130-133.* Maharashtra, Bombay: *ARD 40*; Nagpur: *ARD 167-169, ARD 186* (BLAT).

3. **Laggera flava** Benth. and Hook.f., Gen. Pl. ii. 290. 1873.

Chromosome number: No collection (Previously reported - n = 20, R.C. Gupta and B.S. Gill from Madhya Pradesh).

4. **Laggera pterodonta** (DC.) Sch.-Bip. *ex* Oliver, Trans. Linn. Soc. London 29: 94. 1873.

Blumea pterodonta DC. *in* Wight, Contrib. Bot. Ind. 16. 1834.

Chromosome number: No collection (Previously reported - n = 10, Abraham Mathew and P.M. Mathew from Kerala).

C. **Nanothamnus** T. Thoms.

This is an endemic monotypic genus which differs from *Blumea* and *Laggera* in having distinctly 2-lipped bisexual florets and in lacking a pappus altogether. It occurs in the hills of the Western Ghats in peninsular India.

Nanothamnus sericeus T. Thoms. *in* Jour. Linn. Soc. 9: 342, t. 3, 1867.

Chromosome number: n = 10

Specimens examined: Maharashtra, Khandala: *ARD 47, ARD 197-198* (BLAT).

CONCLUSIONS

1. A study of the chromosome numbers of the species indicates that the commonest base number for the genus *Blumea* is n = 10 which occurs in 11 of the 17 species under investigation. Further, this base number is found in species belonging to all six sections of the genus occurring in India.

2. Three species have a base number of n = 9 and the remaining three have a base number of n = 11.

3. The following four species are polyploids:

B. hieraciifolia - n = 18; *B. fistulosa* - n = 20; *B. lacera* - n = 22; *B. eriantha* - n =30.

This indicates that polyploidy occurs in relation to all three base numbers 9, 10 and 11.

4. *Sections Semivestitae and Macrophyllae*: All species have the chromosome number n = 10. The plants are undershrubs, over 2 m, in height, and grow in forests and along stream banks. The capitula are arranged in large, terminal or axillary panicles.

5. *Section Hieraciifoliae*: *Blumea clarkei* Hook. f. (*n = 10*) also grows up to 2 m and resembles *B. riparia* (Bl.) DC. (Section Semivestitae) in its habit and capitulum size. *Blumea hieraciifolia* (D. Don) DC., with n = 18, is a polymorphous species.

6. *Section Paniculatae*: This section contains 8 species and is represented by all three base numbers 9, 10 and 11.

a) *Blumea fistulosa* (Roxb.) Kurz and *B. sessiliflora* Decaisne (n = 10) resemble each other in having sessile capitula arranged in interruptedly spicate glomerules whereas the other species in this section have paniculate inflorescences. Further, they have a very high coefficient of association (89.4%) based on capitulum characters (Dakshini and Prithpalsingh 1977).

b) *Blumea laciniata* (Roxb.) DC. (*n = 11*), *B. mollis* (D.Don) Merr. (*n = 11*), and *B. lacera* (Burm. f.) DC. (*n = 22*), constitute the next group. They are among the most widespread species of the genus being distributed throughout the tropical regions of the Old World. *B. laciniata* differs from the other two species in having ribbed achenes and pubescent receptacles. *B. mollis* and *B. lacera* are very closely related and it is rather difficult to distinguish the two in herbarium specimens (Randeria 1960). In the field, however, they are easily distinguishable since *B. mollis* has purplish florets and *B. lacera* has yellow florets.

c) *Blumea membranacea* DC. and *B. virens* DC. have n = 9 chromosomes. Morphologically, they are also closely related and the coefficient of association based on capitulum characters is 98.2%, being the maximum for the genus. However, the two species do not show a high coefficient of association with other species of this section or with species of other sections (Dakshini and Prithpalsingh 1977).

7. *Section Oxyodontae*: The base number for all species of this section is n = 10. *Blumea belangeriana* DC. (*n = 10*) is endemic to the west coast of peninsular India whereas *B. eriantha* DC. (*n = 30*) and *B. oxyodonta* DC. (*n = 10*) are widely distributed and a large proportion of specimens have abortive anthers.

8. *Section Dissitiflorae*: The only species of this section for which a chromosome count could be made is *Blumea obliqua* (Linn.) Druce (*n = 10*). It has close affinities with species of *Laggera*, particularly *L. aurita* (Linn.f.) Sch.-Bip.

9. The two related genera, *Laggera* and *Nanothamnus* also have a base chromosome number of n = 10.

10. It is gratifying to note that the results obtained from these cytological studies, in general,

corroborate the inter-relationships of the various species and their taxonomy as derived from previous morphological and anatomical investigations (Randeria 1960).

ACKNOWLEDGEMENTS

I wish to express my deep gratitude to the Ministry of Education, Council for Scientific and Industrial Research, for the grant of a post-doctoral fellowship; to the Principal, St. Xavier's College, Bombay, for providing all facilities for the research work; to Dr. (Mrs.) S.M. Almeida, Head, Botany Department, Mr. M.R. Almeida, Alchemie Research Centre, and colleagues for their help and constant encouragement; to Prof. P.V. Bole and late Dr. N.A. Irani for their assistance in collecting specimens and their constructive suggestions.

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BREEDING ECOLOGY OF THE BRONZEWINGED *(METOPIDIUS INDICUS)* AND PHEASANT-TAILED (*HYDROPHASIANUS CHIRURGUS*) JACANAS IN KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN[1]

N. K. Ramachandran and V. S. Vijayan[2]

(*With five text-figures)*

Key words: *Metopidius indicus, Hydrophasianus chirurgus*, polyandry, dispersal, social subordination hypothesis and breeding behaviour

This paper analyses the breeding requirments of the Jacanas (Bronzewinged Jacana *Metopidius indicus* and the Pheasant-tailed Jacana *Hydrophasianus chirurgus*) in terms of biotic and abiotic factors, and describes some of the breeding behaviour. The study covered three breeding seasons from 1986 to 1988 in Keoladeo National Park, Bharatpur. The relationship between habitat and mating system of jacanas is examined. Both the species did not breed in large numbers in the same year; this difference is explained in terms of habitat requirements. The major abiotic factors determining the breeding season of both species of jacanas seem to be the timing and intensity of south-west monsoon, and the availability of water in the Park in a particular year. Among the biotic factors, availability of food and the presence of suitable habitat are equally important. At the end of the breeding season the adult to immature ratio of bronzewinged jacana was 36:22. The clutch size of pheasant-tailed varied from one to five. Clutch size of four had the highest frequency (0.62) followed by three (0.17). The dispersal of Bronzewinged Jacana is explained in the light of the social subordination hypotheses.

INTRODUCTION

Different aspects of breeding, especially on mating system of many species of jacanas have been reported earlier (Miller 1931, Hoffmann 1949, 1950; Mathew 1964, Dutton 1969, Jenni and Collier 1972, Steyn 1973, Vernon 1973, Wilson 1974, Osborne and Bourne 1977, Jenni and Betts 1978, Chattopadhyaya 1980, Osborne 1982, Fry 1983, Stephens 1984a, b). However, two species of jacanas occurring in the Indian subcontinent have not yet been investigated thoroughly in terms of their breeding habits and habitat, and their relation to the mating system. Mathew (1964) confirmed the existence of polyandry in the Bronzewinged Jacana (*Metopidius indicus*) but did not pursue further the various ecological reasons for polyandry.

The present study examines the breeding requirements of the Bronzewinged (*Metopidius indicus*) and Pheasant-tailed (*Hydrophasianus chirurgus*) Jacanas in terms of biotic and abiotic factors, and describes the breeding behaviour and the relationship of habitat and mating system.

STUDY AREA

The study was conducted in Keoladeo National Park, Bharatpur, a man-modified wetland situated in the Indogangetic plains at the confluence of the rivers Banganga and Gambir (27° 7.6' to 27° 12.2' N and 77°29.5' to 77°33.9' E) and at an average elevation of 174 msl. The Park has a boundary wall and is surrounded by agricultural fields and 18 villages. The total area of the Park is 29 sq. km. It is almost flat with a gentle slope towards the centre forming a depression of 8.5 sq. km. The aquatic area of the Park has been divided into various unequal compartments or blocks by means of dykes (Fig. 1). A metal topped road divides the Park lengthwise into two large blocks. On either side of the road, the wetland area is comparatively deeper than the rest of the area and holds water even in summer.

Bharatpur experiences extreme climatic conditions and during the study period temperature varied from 2.5°C to 45.33°C. The temperature showed seasonal fluctuation during the study period (Fig. 2). The lowest average temperature was in

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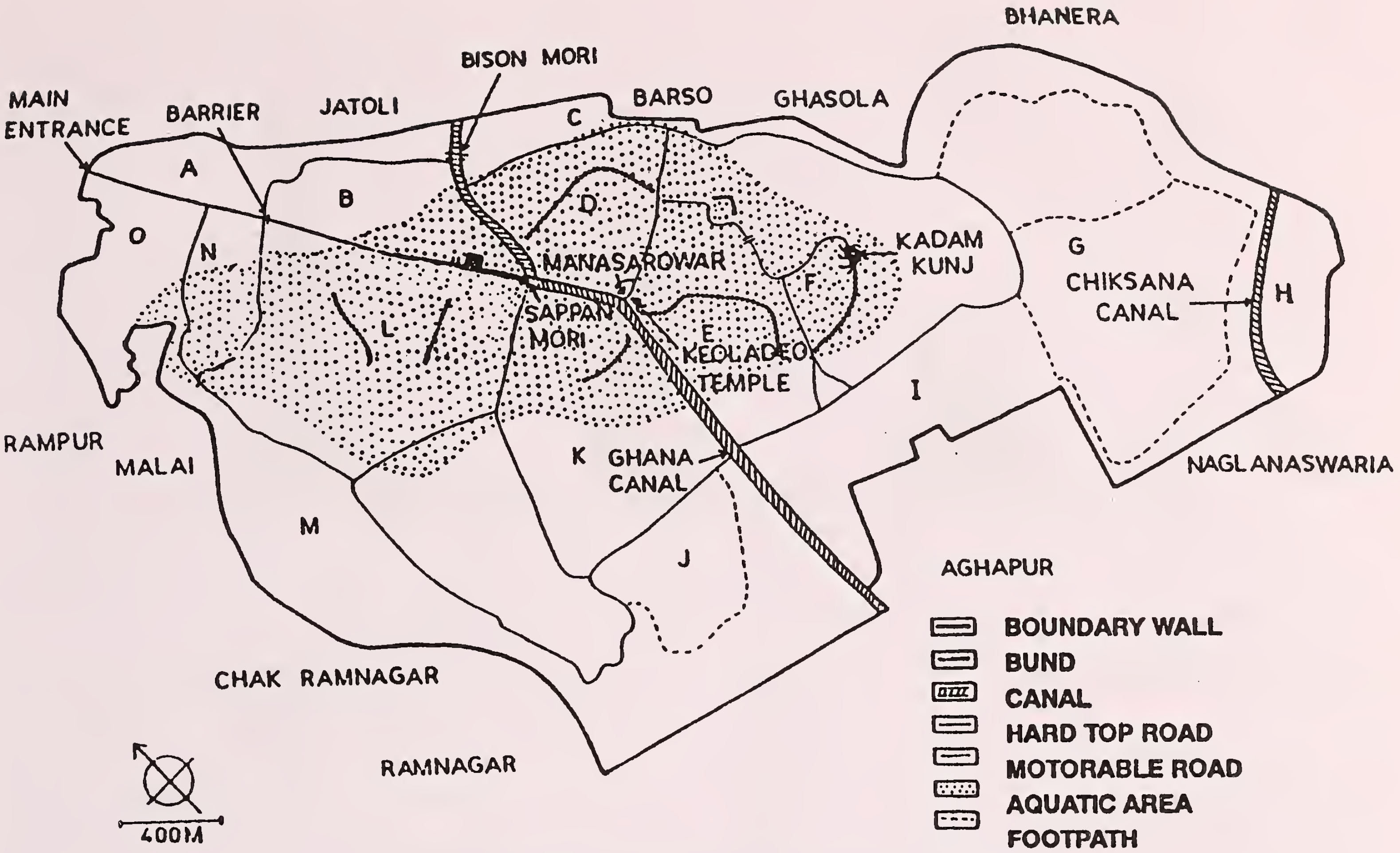
[1] Accepted November 1992.

[2] Bombay Natural History Society, Hornbill House, Dr. Sálim Ali Chowk, Bombay-400 023. *Present Address:*Salim Ali Centre for Ornithology and Natural History, Kalampalayam P.O., Coimbatore, Tamil Nadu - 641 010.


BHANERA
BISON MORI
MAIN ENTRANCE
BARRIER
JATOLI
BARSO
GHASOLA
A
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KADAM KUNJ
G
CHIKSANA CANAL
H
SAPPAN MORI
L
E
KEOLADEO TEMPLE
F
I
RAMPUR
MALAI
K
GHANA CANAL
NAGLANASWARIA
M
J
AGHAPUR
CHAK RAMNAGAR
RAMNAGAR
400M
BOUNDARY WALL
BUND
CANAL
HARD TOP ROAD
MOTORABLE ROAD
AQUATIC AREA
FOOTPATH

Fig. 1. Map of Keoladeo National Park, Bharatpur, Rajasthan.

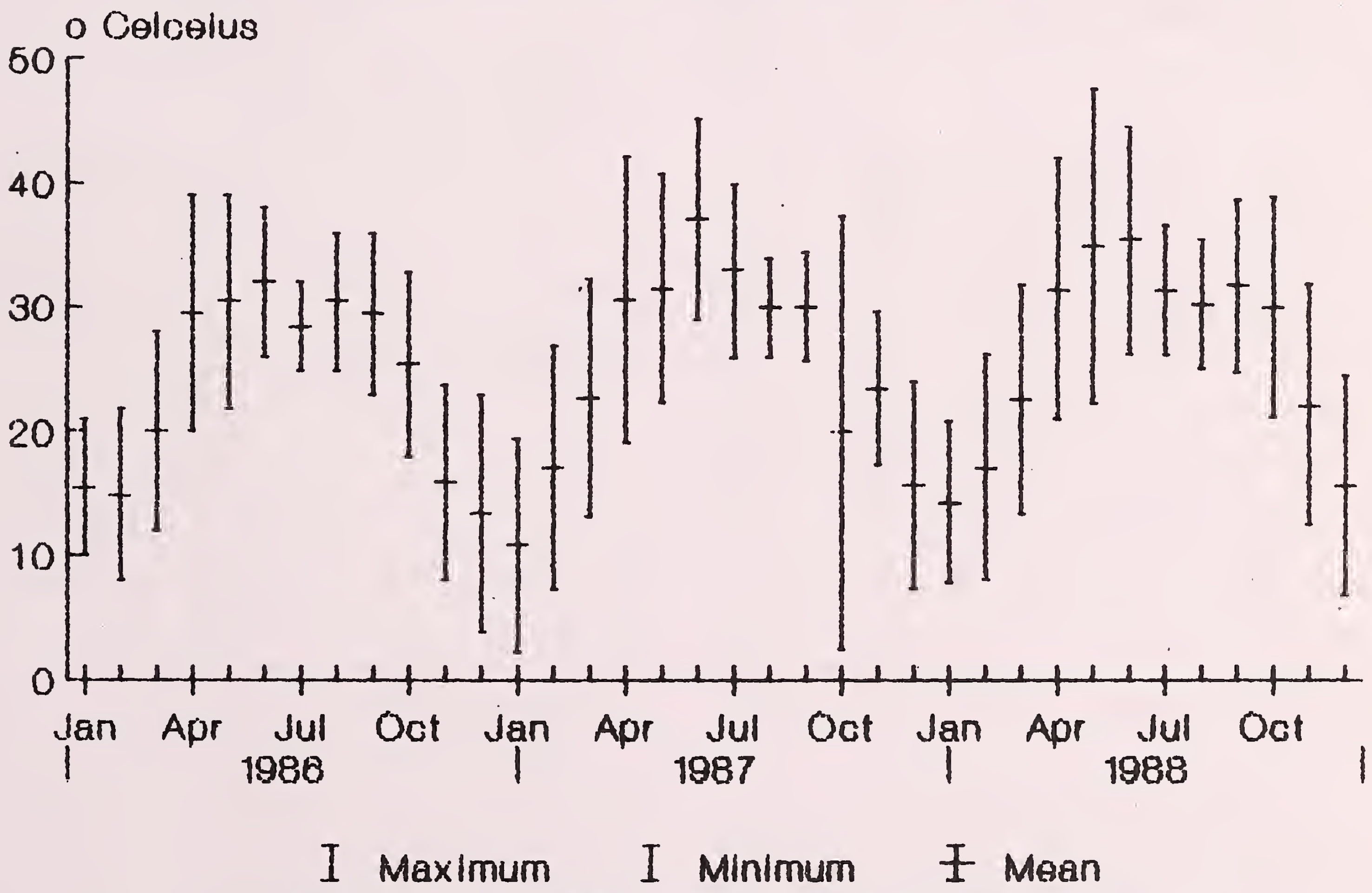

Fig. 2. Monthly variation of minimum, maximum and mean temperature in the park.

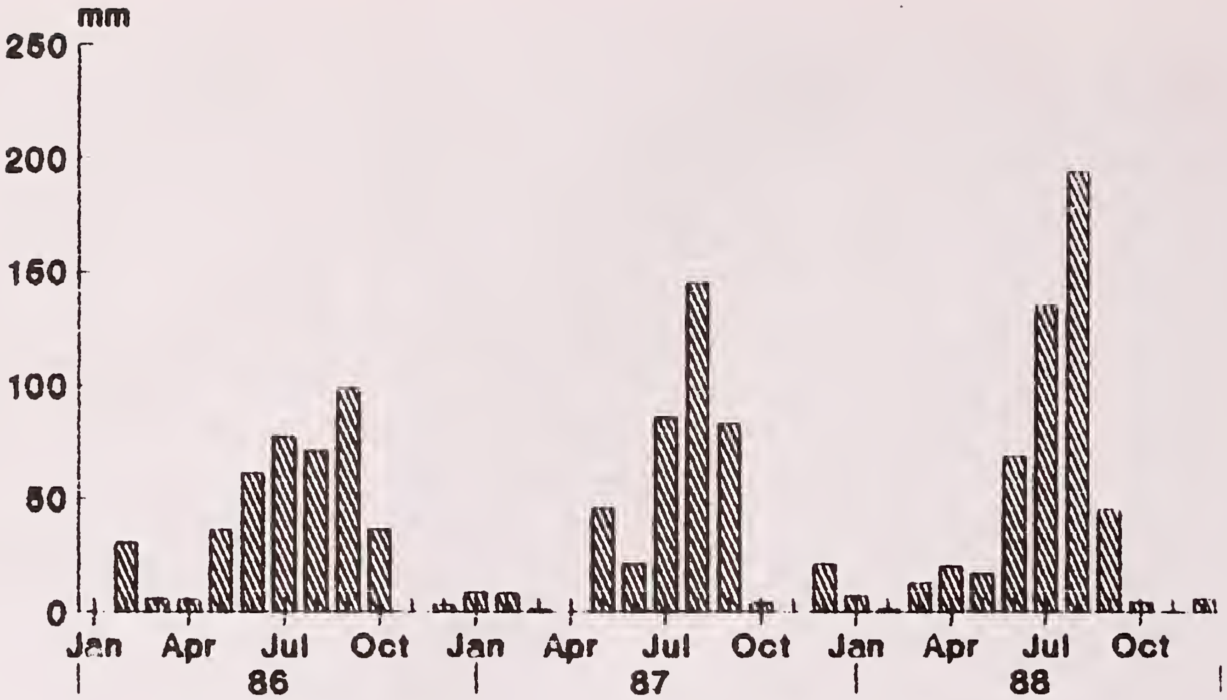

Fig. 3. Monthly variation of rainfall in the park from 1986 to 1988.

January 1987 and the highest in June of the same year.

The precipitation in Bharatpur is from the south-west monsoon which sets in by the end of June and continues up to September, sometimes extending to October. The total rainfall was 424.7, 423.4 and 614.2 mm during 1986, 1987 and 1988 respectively. The monthly rainfall varied from year to year (Fig. 3).

Water depth inside the Park showed characteristic monthly fluctuation (Fig. 4). During the study period the highest depths in each year recorded were in January 1986, October 1987 and August 1988. Water depth inside the Park increases as the water is released from Ajanbund, a reservoir situated away from the Park. There is an outflow in the initial stage; if the quantum of water received is large, a part of it is let off to the agricultural fields. Thereafter water losses occur only due to evaporation, percolation and evapotranspiration.

A detailed description of the topography, habitat, fauna and flora is given by Ali and Vijayan (1983), Vijayan (1988) and Prasad (1988, 1989).

Methods and Materials

Spot mapping (Kendeigh 1944) was employed to census the nesting jacanas following each family regularly after the onset of monsoon. When a nest was spotted the following parameters were recorded: (1) location, (2) nesting material, (3) plant species present in the immediate vicinity of the nest, (4) water depth at the nesting site, and (5) clutch size. If the chick had already fledged, they were counted and location was plotted on a map along with their parents. Morphometrics of eggs and the habitat quantification could be made only in the case of the Pheasant-tailed Jacana.

Habitat quantification was made by measuring the vegetation cover by the quadrat charting method of Mueller-Dombois and Ellenberg (1974). The quadrat (0.5 x 0.5 m) was divided into 100 columns by means of strings and all the plants in each column were identified and noted. Quadrats were placed at random. In the nesting site, stratified random sampling followed at 5 m intervals, on either side from the centre of the nest. Three samples, one each from either side and one from the centre of the nest were taken. These samples were subjected to clustering (Wilkinson 1988) using 1-Pearson correlation coefficient as the distance matrix to find out the similarity of nesting habitats.

Macroinvertebrate were sampled using a modified version of Wisconsin trap (Welch 1948). The macroinvertebrate taxa were identified up to orders in the case of aquatic insects only.

The data on the macroinvertebrate and

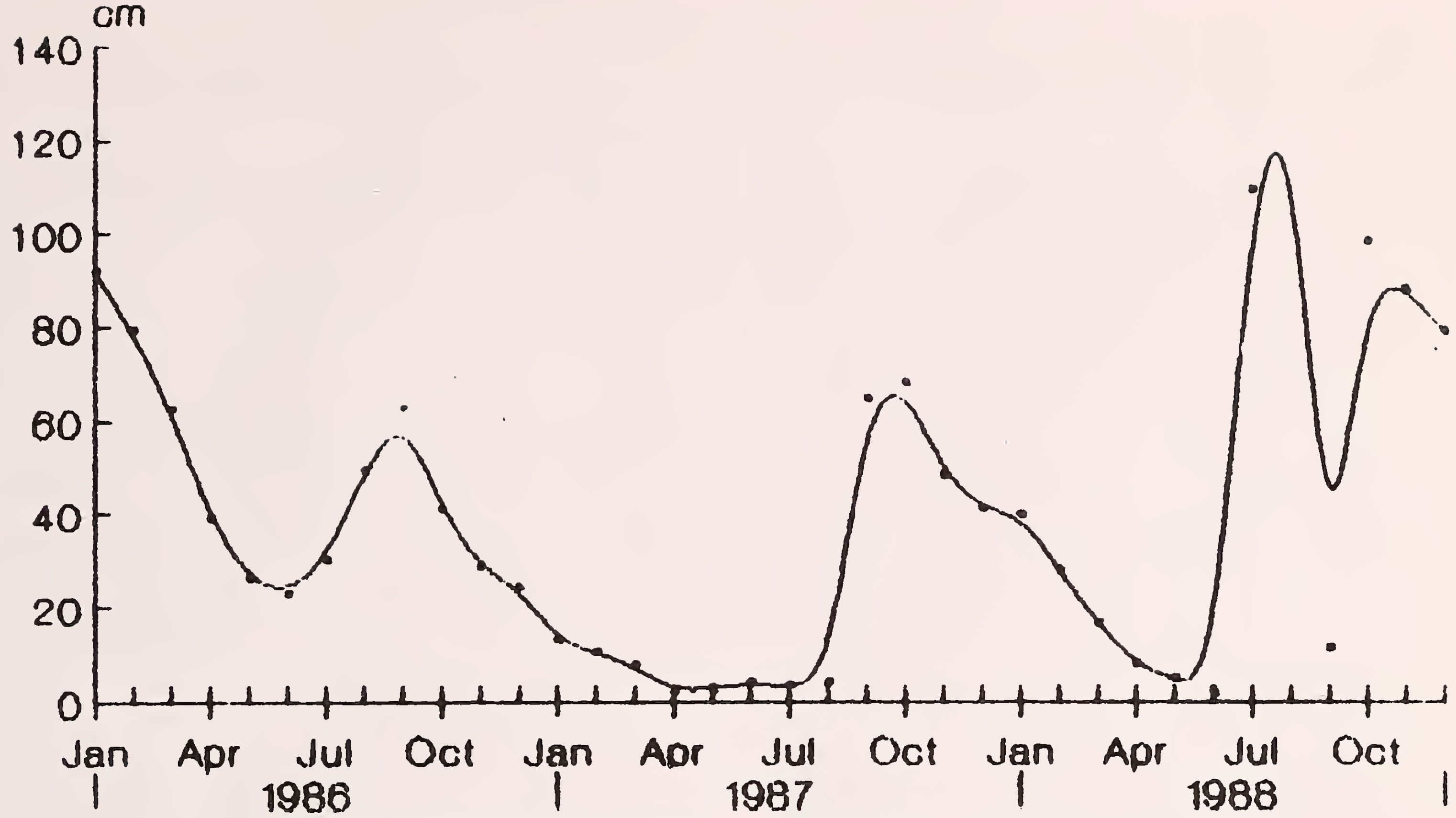

Fig. 4. Monthly variation of the water depth in the park from 1986 to 1987.

vegetation were compared between the feeding areas of the Bronzewinged and the Pheasant-tailed Jacanas using Mann-Witney U test (Wilkinson 1988).

Morphometric measurements of eggs were taken using vernier callipers. The length and width were measured at the highest points of the egg, obtained by sliding the callipers gently on the egg. The weight of the egg was measured using a Pesola spring balance of 30 g capacity.

Since colour marking of individuals was not permitted by the Forest Department in the study area, data on their mating system are circumstantial.

Results and Discussion

BRONZEWINGED JACANA

During the study period (1986-1987 to 1988-1989) Bronzewinged Jacana bred inside the Park in good numbers only during 1986-87. During 1988-89 only one pair bred in the study area.

Mating: Mating was observed only once in the Bronzewinged Jacana at 16.45 hr in July 1986. The female stood on an *Ipomoea* twig while the male approached her, and mounted quietly without any display. The act of copulation was accomplished within two minutes. While mounting, the male wriggled its body from side to side and flicked its tail up and down as if balancing itself on the top of the female. The female remained half crouched and motionless with its head stretched forwards. The male flapped its wings, when it was about to dismout. Once mating was over the male flew off and the female began feeding from the same area.

Nesting substrate and habitat: Out of the four nests located during 1986, two were on an *Eichhornia* patch and one each on *Ipomoea* and a float of decaying litter overgrown with grass. However in most cases, the habitat where chicks with parents were located had *Eichhornia crassipes, Ipomoea aquatica, Hydrilla verticillata* and *Ceratophyllum demersum.* An ideal breeding habitat of the Bronzewinged Jacana is formed by patches of *Eichhornia crassipes* or *Ipomoea aquatica* with other aquatic plants such as *Hydrilla verticillata* and *Ceratophyllum demersum.* When the nesting habitat had *Eichhornia crassipes,* the presence of grass patches (*Paspalum distichum*) was noticed nearby. The major function of *Ipomoea aquatica* and grass patches in their breeding habitat seems to be protection of their chicks from predators. This was evident from the behaviour of the bird: on hearing the warning call from the male on the approach of a predator, usually the chicks hide themselves in these patches.

Territory: The territory size appears to be 50 x 50 m. The available mosaic of different vegetation patches inside the Park suggests that all other territories are of the same size as the one measured.

Nest: The nest was poorly built. Of the five nests with eggs discovered during the study (four in 1986 and one in 1988) two were on floats of grass (*Paspalum distichum*), one on an *Ipomoea aquatica* patch and another on an *Eichhornia crassipes* patch. The fifth one was sighted on a grass mat (*Paspalum distichum*). Three nests were lined with 3-4 twigs of *Hydrilla verticillata* and the rest had no lining.

Eggs: The morphometrics of only one clutch of three eggs could be obtained. The average length and breadth were 35.5 and 24.8 mm respectively. The eggs were glistening chocolate brown with black blotches all over them. The colour of the egg merged well with that of the substrate.

Clutch size: A total of 43 clutches were recorded by the end of September. Among these, five were as eggs and the rest had nestlings. Of the five clutches, two had three eggs each, and one each had one, two and four eggs. Three appears to be the highly probable clutch size as the families with three chicks were more in the breeding population of the Bronzewinged Jacana during 1986. The predation of clutch is not likely in this species as the nests were placed farther apart and hence the common predator, the marsh harrier *Circus aeruginosus* could not concentrate in certain areas and maximise predation as in the case of the Pheasant-tailed Jacana. Of the five clutches, the one with two eggs was preyed upon by a crow *Corvus splendens*. Two clutch size of four and three disappeared. The reason for the disappearance was not clear. Another clutch with a single egg was on an *Eichhornia crassipes* patch but was disturbed by the removal of *Eichhornia crassipes* by man. After the removal only a small patch of *Eichhornia* with the clutch remained. Still, the bird incubated it for 3 days. The egg was not seen subsequently but the bird was present in the same area. The prolonged disturbance by the *Eichhornia crassipes* collectors and destruction due to exposure of habitat around the nest, may have been the cause of failure.

Recruitment of chicks and dispersal: A total of 82 chicks by 38 individuals of the Bronzewinged Jacana were recruited into the population from June to September 1986 (Table 1). The population had lost 11 chicks by July end. After July it was not possible to keep track of each family as the chicks started dispersing and establishing their own group.

Several hypotheses have been put forward to explain the difference between dispersers and non-dispersers. Among these the social subordination hypothesis of Christain (1970) explains adequately the dispersal of the Bronzewinged Jacana. This hypothesis proposes that as the density increases, the resulting shortage of resources leads to increased levels of aggression, and this in turn forces social subordinates to disperse into sub-optimal habitats.

As the adult of the Bronzewinged invariably chased away juveniles of its own species, this could be considered as the consequence of congestion and resulting food shortage. The dispersal helps in regulating the population (Wynne-Edwards 1986) and inbreeding.

However, the population of the Bronzewinged Jacana became drastically reduced towards the end of September compared to that in June and July. The average adult to immature ratio of the Bronzewinged Jacana in September inside the Park was 36:22. The major reason for this fall was dispersal. Since none were noticed dead or caught by predators during the study period the mortality by predation and natural death may be playing only a secondary role.

Chicks: Two morphologically distinct stages can be distinguished in their development from chick to adult: the early stage when they are protected by parents and the later stage when they are free. The small chicks have light brownish downy feathers and two dark brown bands running from head to tail on the ventral side. At the immature stage they look almost like the non-breeding adult of the Pheasant-tailed Jacana. They do not have a white supercilium and the feathers are light brown. During this stage they are totally independent and feed in groups most

TABLE 1

RECRUITMENT AND MORTALITY OF CHICKS IN THE BRONZEWINGED JACANA DURING 1986

				Blocks				
Recruitment	L west	L	B	D	E.	K	CANAL	Total
June	3	1,1,4	3,3	3	3,3,3,2	—	2	31
Early July	1	1,1,3	—	—	1,2	—	—	9
Late July	2,1	1,2,3,1	3	—	3,2,2,1	—	2	23
July Mortality	1	1	—	3	6	—	—	11
August	—	4,1,2	—	1	3	3	—	14
August Clutch	—	4	1	3	—	—	—	8
September	—	2	—	—	2	—	—	4
September Clutch	—	2	—	—	—	—	—	2
Total no. clutches	4	16	4	3	12	1	2	42
Total no. of Chicks	8	27	9	4	27	3	4	82

of the time.

Parent to chick relation: Although the chicks are precocial they always follow the male bird. The female bird stays nearby, within the territory feeding or helping the male in chasing away intruders and giving warning signals to the chicks of impending danger like the approach of predators. Parental care by the male includes brooding, attending and defending, but never feeding the chicks. The contribution of the female parent is insignificant compared to that of the male. The chicks feed themselves. These behaviour have been reported in the American Jacana *Jacana spinosa* also (Jenni and Collier 1972). The chicks left their parents once they attained the juvenile stage. The exact duration of staying with the parent is not known.

Antipredation tactics of chicks and parents: Two types of antipredation tactics were employed to protect the young: attacking the predator and distracting their attention. The major predator of the Bronzewinged Jacana is the marsh harrier *Circus aeruginosus*. The male bird with chicks usually fed inside the *Ipomoea aquatica* patch or grass patch. Whenever a raptor appeared overhead the parents, mostly the male produce a shrill alarm call, fly into the open water area of the breeding habitat and freeze. The chicks on hearing the warning, hide amidst the vegetaion. The behaviour of adult is the same even when unaccompanied by chicks. When an adult was attacked by a marsh harrier it countered by warding off the harrier with its legs and made the harrier to retreat.

Once a parent, when disturbed by the observer scooped up the chick in its wing and flew and landed 4-5 m away safely. This behaviour was reported earlier by Ali and Ripley (1983). Chick-carrying is also reported in the African jacana *Actophilornis africanus* (Hopcraft 1968).

On another occasion when a family of a Bronzewinged Jacana was chased by the observer and made to stay in an open area, the parents flew away making continuous shrill calls. The observer, reaching the spot, could not trace the chicks and hence moved away but continued watching the parents. On seeing the observer leaving the area the male parent uttered a feeble call and the chicks ran from the open area towards the male. Ali and Ripley (1983) reported that the bird can submerge itself in water keeping only the bill exposed; this must have happened in the above case also.

The gregarious habit of immature birds who, often form a group on being chased away by the respective parents, feed and roost together. This is probably an antipredatory behaviour.

During the initial period when the chicks are with them, the parents aggressively chased away other species, namely Indian moorhen *Gallinula chloropus* and the immature individuals of Bronzewinged Jacanas, whenever they tried to trespass into the territory. Intrusion by immature Bronzewinged Jacana were not tolerated either in the initial period or later, when the chicks became independent. The moorhens were chased only when they tried to enter the *Ipomoea aquatica* patch where the chicks used to feed. Only the lesser whistling teal *Dendrocygna javanica* with its chicks was allowed to feed in the territory.

Polyandry: Jenni (1974) states that there are two radically different ways by which polyandry can function: (1) The males can cooperate with one another and share the role played by a single male in a monogamous system; (2) the behaviour of each male can be independent of other males and each male can interact with females as if the relationship were monogamous. Two species of jacanas, namely Pheasant-tailed (Hoffmann 1949, 1950) and Bronzewinged (Mathew 1964) occurring in the Indian subcontinent were reported to have all the points listed by Jenni for his second type of polyandry. However, Jenni in his review cast doubt on the typicality of polyandry in the Bronzewinged Jacana.

Through the present study evidences were gathered against typicality of polyandry in the Bronzewinged Jacana. The evidences mainly come from the study of their distribution during the breeding period. This study showed that each pair was widely separated, often by physical barriers such as dykes with trees. Furthermore, each pair was sighted almost always in the same area throughout the breeding season and beyond (July to January). This shows that the Bronzewinged Jacana in Keoladeo National Park was not polyandrous during 1985-86. Another point against polyandry is their non-gregarious habit before breeding. Inside the Park, they were rarely seen in flocks. Only after winter when the area started drying up, did they feed together and that too not as coherent flocks as that of the Pheasant-tailed Jacana. The possible reason for their not appearing as polyandrous may be the absence of long stretches of habitat. The habitats were isolated, small patches in which a female cannot hold more than one male.

PHEASANT-TAILED JACANA

Most of the data on the breeding ecology of the Pheasant-tailed were collected during 1988-89 from the Park. It includes aspects such as nest, egg laying, clutch size, egg morphometrics, chicks, breeding habitat and behaviour. In addition to this, some data on their breeding ecology were obtained from outside the Park during 1986-87.

Nest: A total of 40 nests were recorded as distributed among blocks B, D, E, F, K and L (Table 2). The water depth near the nest varied from 71 to 140 cm, average depth 98.4 cm (SD ± 15.9). Block F had the maximum number of nests followed by block K. Nests were located on three types of substrates, namely grass float (*Paspalum distichum*), grass mat (*P. distichum*) and *Ipomoea aquatica* plus *Nymphaea nouchali* float. Grass floats were decayed grass litter with or without live vegetation, whereas grass mats were thick, living grass rooted on the ground. Of the 20 nests where nesting substrate could be examined, 10 were on grass float and four on grass mat. The rest were on mat formed by different combinations of *Ipomoea aquatica, Nymphaea* spp., *Nymphoides* spp. and *Paspalum distichum. Hydrilla verticillata* were used as nesting material except when the nest was built on grass float.

Egg laying: Egg laying was observed once, outside the Park in a small village pond (Banera pond) maintained for the cultivation of *Trapa natans,* but also containing *Ceratophyllum demersum* and *Hydrilla verticillata.* The female before laying eggs preened itself for a while and pulled up two or three twigs of *H. verticillata* and *C. demersum* which were present around the nest. After that the bird positioned itself on the nest with the cloacal region inclined towards the nest and kept its legs wide apart. The angle between the cloacal region and the nest surface was effected by bending the knee slightly and while doing so it ruffled the body feathers once and the golden feathers on the neck were kept raised. Then it started moving the head up and down rather rhythmically. It again adjusted the position of the

Table 2
DISTRIBUTION OF THE NESTS OF THE PHEASANT-TAILED JACANA INSIDE THE PARK

	Number of nests in blocks							
Clutch size	B	D	E	F	K	L	Total	Frequency distribution of clutches
5	0	0	0	0	1	0	1	0.034
4	0	0	1	12	4	1	18	0.621
3	1	0	0	1	2	1	5	0.172
2	1	1	0	1	1	0	4	0.138
1	0	0	0	0	0	1	1	0.034

legs increasing the angle between cloacal region and nest. This was followed by laying the egg within fractions of a second. The whole process described above was completed within two minutes. Soon after laying the female flew to a distance of about seven metres.

As soon the female left the nest after laying, a male bird (identity based on size) ran towards the nest, scooped up the egg in its beak and flew away. When it had flown about 6 m the egg was dropped into the water. This type of behaviour has not been reported earlier. Whether the bird intended to destroy the egg or shift the site was not clear. In all probability it was an accident, because egg shifting has been reported earlier in the pheasant-tailed jacana. Two different ways of egg shifting are reported: pressing the egg between throat and breast and dragging or rolling it over the matted vegetation while the male walks backwards (Ali and Ripley 1983) or holding the pointed end of the egg between the mandibles and dragging it backwards (Serrao and Shekar 1962). During the study period, a clutch of three eggs was found shifted from its previous location.

Clutch size: Although 40 nests of the Pheasant-tailed Jacana were recorded, information on egg production per nest is available only for 29 nests. Clutch size varied from one to five (average = 3.48). Clutch of five was rare and four was the most common. Block F had the maximum number of nests with 4 eggs (Table 2). The frequency distribution of clutch was calculated by dividing the number of nests with the clutch of different size by the total number of nests (Cochen 1988).

Colour and morphometrics of the eggs: Two types of eggs could be distinguished; one with a more or less perfect oval shape and the other with rounded top. The colour of the egg seems to undergo changes as incubation progresses. Fresh eggs were glossy-greenish bronze and became rufous-brown later. Eggs were not marked unlike those of the Bronzewinged Jacana. Morphometrics of 35 eggs of the Pheasant-tailed (Table 3) show that the size was almost the same as reported earlier (Baker in Ali and Ripley 1983).

Table 3
MORPHOMETRICS OF THE EGG OF THE PHEASANT-TAILED JACANA (N = 35)

Parameters	Maximum	Minimum	Mean	SD
Breadth (mm)	29.000	27.200	27.963	0.462
Length (mm)	40.500	29.500	36.779	2.170
Weight (g)	20.000	15.000	17.360	1.411

Breeding habitat: The breeding habitat of the Pheasant-tailed Jacana was assessed visually by recording the presence or absence of vegetation within a five metre radius of the nest. A total of 13 species of plants were present around the nest. Common among them were *Nymphaea nouchali, Nymphoides* spp., *Paspalum distichum* and *Ipomoea aquatica.* It is to be noted that *Nymphaea nouchali* and *Nymphoides* spp. had a very restricted distribution compared to that of *P. distichum* inside the Park.

In general, the breeding habitat of the Pheasant-tailed Jacana should have cover of vegetation patches of different species of aquatic macrophytes with intermittent openings containing submerged aquatic vegetation. The thick and expansive growth of any vegetation, especially *Paspalum distichum,* is unfavourable for their breeding.

To get a clear picture of the similarity of the Pheasant-tailed Jacana's nesting habitat, vegetation was quantified using 0.5 x 0.5 m chartered quadrat.

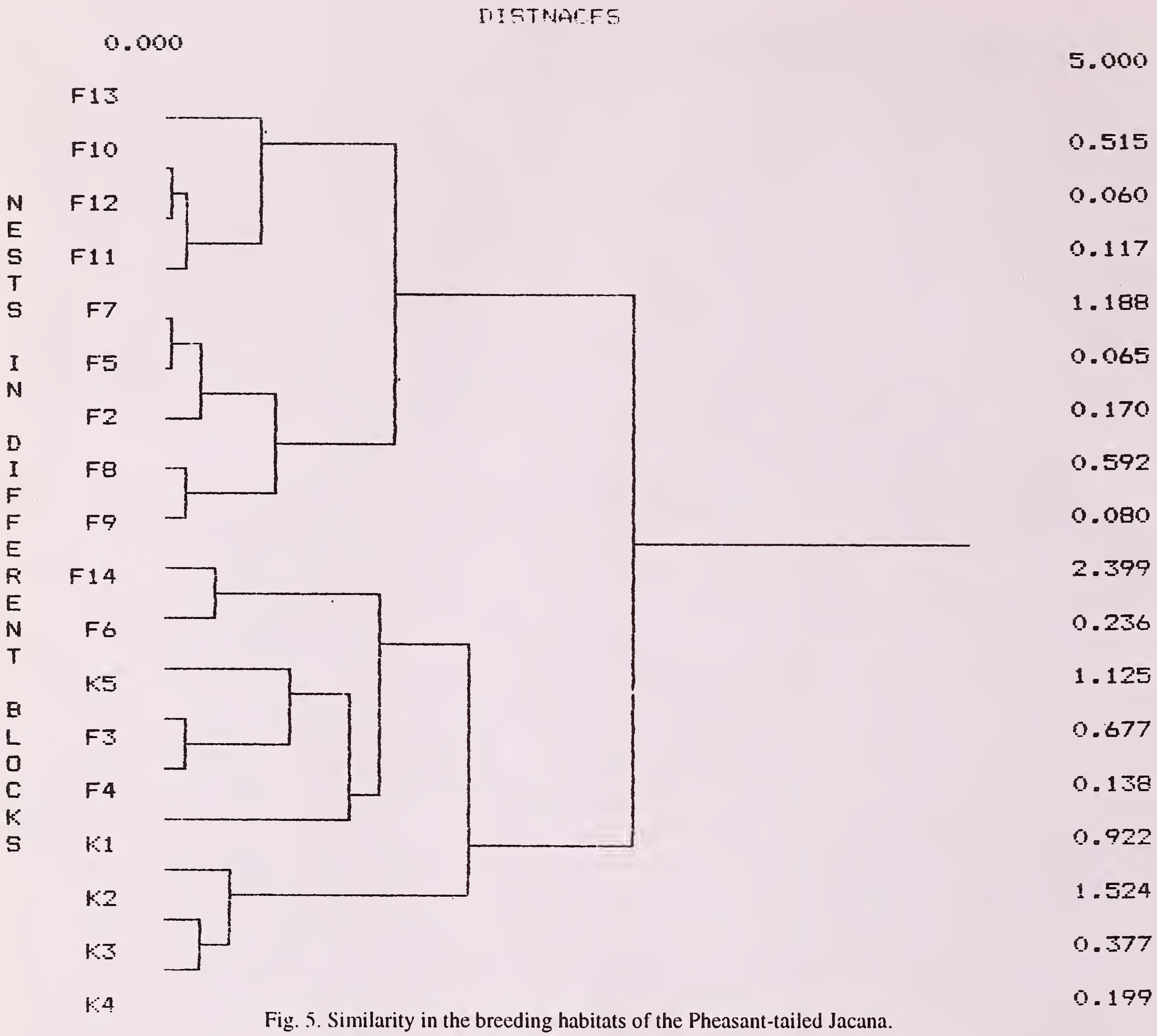

Fig. 5. Similarity in the breeding habitats of the Pheasant-tailed Jacana.

In all, 140 such samples were taken. These data were pooled together and a dendrogram was drawn using 1-Pearson correlation coefficient as the distance matrix and Ward minimum variance linkage as the clustering strategy (Wilkinson 1988). Almost all the nesting habitats clustered together at relatively lesser distance, indicating that nesting habitats are homogenous (Fig. 5).

Predation: The marsh harrier was the major predator of the eggs. Contents of most nests might have been preyed upon by them because marsh harriers were observed in more numbers in the blocks where the Pheasant-tailed were nesting in some numbers. Actual predation by marsh harrier was observed in four instances. As the four nests were close by, the predator could save searching time and hence, did not have to range over a large area. On one occasion marsh harriers were hunting in pairs when an incubating Pheasant-tailed Jacana from the neighbourhood came to the rescue of its neighbour. However, while both individuals of jacana were engaged in chasing away one marsh harrier, the other preyed upon the nest contents.

Breeding season of the jacanas: Both the species of jacanas commence reproductive activities with the onset of monsoon and subsequent flooding of the area. The striking difference between the two species is the development of breeding plumage in the Pheasant-tailed Jacana and its absence in the Bronzewinged. The former species invariably arrives in the study area in breeding plumage after the flooding and hence, it was difficult to record the commencement of nuptial plumage.

Ali and Ripley (1983) gave the breeding season of the Bronzewinged Jacana as from June to September and further add that breeding commences soon after the setting in of the south-west monsoon. During 1986-87 nesting was noticed in the first week of June and during 1988-89 at the end of June. In the former year the hatching of eggs was completed by September.

The Pheasant-tailed Jacana bred inside the Park only once during the three seasons studied. Breeding commenced towards the end of June and was completed by September. Ali and Ripley (1983) recorded their breeding season principally as from June to September during the south-west monsoon.

Thus, the breeding season is the same for both species. Therefore, the reason for both the species not breeding together in the same location in large numbers is probably due to competition for resources, mainly food and space. However, the absence of any antagonistic behaviour by the Pheasant-tailed Jacana towards the pair of the Bronzewinged Jacana which nested very close is not supportive of the above speculation. Since it was only one instance, a definite conclusion is not possible.

FACTORS DETERMINING THE BREEDING SEASON

BIOTIC FACTORS

Day-length: Day-length is a proximate factor in the timing of breeding (Perrins and Birkhead 1983). In both species of jacanas, the timing of breeding appears to be influenced by the day-length. Both of them breed with the onset of south-west monsoon. The breeding season coincides with the period when day-lengths are comparatively longer than during the approaching winter. This suggests that the day-length may be playing a role in deciding the timing of breeding. Moreover, both species finish breeding activity towards the end of September.

Temperature and humidity: The Pheasant-tailed and Bronzewinged avoid extreme temperature. Breeding occurs when the maximum temperature is between 33°C and 40°C, and the minimum between 18°C and 26°C (during 1986 and 1988 from July to October). The humidity ranged from 50% to 73% during breeding period of both species.

Rainfall and water input: The major abiotic factor in deciding the breeding season of both species is rainfall and the subsequent flooding of the Park from the waters of Ajanbund. This is evident from the failure of breeding in both species when the monsoon failed in 1987. During 1986, when the rainfall was 424.7 mm, the Pheasant-tailed failed to breed, whereas the Bronzewinged bred inside the Park. The factors responsible for their breeding are (1) the timing of rain, (2) rainfall and (3) water input from Ajanbund. Commencement of rain during 1986, 1987 and 1988 was almost the same. Rainfall in 1988 was higher than in 1986 and 1987 (Table 4). The water input into the system was minimum during 1986 and maximum during 1988 (Table 4). Despite the low quantum of water released to the Park during 1986, the stored water of the previous years made the total water availability in the Park in 1986 almost the same as in 1988. Thus, the failure of breeding in the Pheasant-tailed Jacana in 1986 may be due to differences in the habitat requirement and not related to the availability of water. The abundance of *Eichhornia crassipes* and *Ipomoea aquatica* provided ample nesting habitats for the Bronzewinged Jacana during 1986. But habitat with sparse grass and submerged vegetation, required by the Pheasant-tailed Jacana was rare and hence it did not breed. In 1988 when suitable habitat was available for the Pheasant-tailed it bred in good numbers. Therefore, although rainfall and water input are basic proximate factors in deciding the breeding season, actual breeding takes place only when the required breeding habitats are available.

Food: Both the Bronzewinged and Pheasant-tailed Jacanas were reported to feed on aquatic macrophytes and macroinvertebrate (Ali and Ripley 1983). Visual observations made in the present study,

TABLE 4
RELATION BETWEEN DIFFERENT HYDROMETEOROLOGICAL FACTORS AND BREEDING OF JACANAS

Year	Timing of rain	Rainfall (in mm)	Water input (in M m^3)	Breeding status	
				PJ	BJ
1986	June to October	424.7	0.017	nil	yes
1987	July to September	423.4	6.768	nil	nil
1988	June to October	614.2	13.730	yes	nil

while corroborating their findings, identifies some of the major macroinvertebrates consumed by the Bronzewinged Jacana. It includes (1) aquatic spiders (Arachnida), (2) *Cassida circumdata* (Coleoptera), (3) aquatic bugs, (4) *Ranatra fuscata* (Hemiptera), and (5) *Planorbis* sp. and *Lemnea* sp. (mollusca). Analysis of the stomach content of one dead Pheasant-tailed showed 70% of vegetable matter and 25% of molluscan shell. The coincidence of breeding season with the peaks in biomass production of both aquatic plants and macroinvertebrate suggests a strong relation between food availability and breeding in both species of jacanas. The failure of breeding by the Pheasant-tailed Jacana inside the Park during 1987 and their breeding outside the Park in a village pond can be explained by the availability of more food in the latter area.

Habitat: The breeding habitats of the two species were totally different. The Bronzewinged Jacana had abundant growth of *Eichhornia crassipes* and *Ipomoea aquatica* and other aquatic plants such as *Hydrilla verticillata, Ceratophyllum demersum* and *Najas minor.* The presence of such vegetation, especially the *H. verticillata* and *C. demersum* appeared to be essential for their reproduction. This is amply proved by the complete failure of breeding or reduced number of clutches produced when these plants were rare in the study area during the study period. The Pheasant-tailed Jacana requires habitats containing sparse grass (mostly *Paspalum distichum*), *Nymphoides* spp. and other hydrophytic plants. During 1988 the areas where they bred in good numbers inside the Park (Blocks F and K) were flooded with water consequently there was an abundance of scattered litter. In no other year did such a floating mass of grass litter occur inside the Park.

To study the role of different factors responsible for the difference in the habitat preference of the two species of Jacanas, macroinvertebrate, depth (1987 data) and vegetation (1988 data) were sampled from the feeding areas of the two jacanas and compared using non-parametric test. For the Pheasant-tailed Jacana, macroinvertebrate samples were collected only from Banera pond just outside the park (the species did not breed inside the Park). Vegetation was sampled from both Banera pond and from within the Park. For the Bronzewinged, vegetation, macrophytes and depth were sampled from the Park only.

The macroinvertebrate taxa present in the feeding area (inside the Park) of the Bronzewinged Jacana were Coleoptera, Diptera, Hemiptera, Odonata, Mollusca and some unidentified larvae. The major contribution to the total number of macroinvertebrates was by Mollusca followed by Odonata (Table 5). The total mean number of macroinvertebrates was 19.25 and the mean water depth 31.1 cm.

The macroinvertebrate taxa collected from the feeding area of the Pheasant-tailed Jacana in the village (Banera) pond were Coleoptera, Diptera, Hemiptera, Odonata, Oligochaeta and Mollusca. The mean total number of macroinvertebrates was 40.3 and the major contribution to the total was by Mollusca (Table 5). The average water depth of this pond was 24.4 cm.

The feeding areas of the bronzewined inside the Park and in that of the Pheasant-tailed in Banera pond differed in water depth (U = 72; P = 0.004) and total number of macroinvertebrate. The taxa which differed significantly were Mollusca and Odonata (Table 5). Among these taxa, Mollusca were abundant in the Banera pond and where the Pheasant-tailed bred during this season. Hence, high availability of Mollusca is one of the important factor for the Pheasant-tailed Jacana while breeding as it

Table 5

DIFFERENCES BETWEEN FEEDING AREA OF THE BRONZEWINGED JACANA (PARK: n = 8) AND THE PHEASANT-TAILED JACANA (BANERA: n = 10) IN THE ABUNDANCE OF DIFFERENT MACROINVERTEBRATE TAXA DURING THE BREEDING SEASON 1987-88

	Bronze-winged	Pheasant-tailed	Mann-Witney U test	
Taxa	Mean	Mean	U Value	P*
Coleoptera	9.125	6.000	51.5	0.303
Diptera	0.375	0.300	45.5	0.533
Hemiptera	0.750	1.400	36.0	0.702
Odonata	1.625	0.200	75.0	0.001
Oligochaeta	0.000	0.100	36.0	0.371
Mollusca	7.000	32.300	0.0	0.000
Miscellaneous	0.375	0.000	55.0	0.039
Mean of total	19.250	40.300	5.0	0.002

Note: All the P values are rounded to three digits.
*$P \leq 0.05$ is significant.

may provide the necessary calcium for the production of egg shells.

Though the water depth of Banera pond and the Park differed, it may not indicate a significant ecological difference as the selection of habitat for breeding depends on other parameters of the habitat also.

The vegetation was not listed by species, but according to leaf size, because it provides a more realistic picture of ecological requirements. The different categories of vegetation is explained in Table 6. The feeding area of the two jacanas differed significantly in the types of vegetation cover (Table 6). In the case of the Bronzewinged, submerged vegetation was abundant and grass was minimal; for the Pheasant-tailed open water and submerged vegetation (Table 6). Since the territory of each individual was a mosaic of different patches of vegetation, the individual abundance of different patches of vegetation types may not be the deciding factor but the proportional representation of them constituting a mosaic is important.

It is not necessary that the ideal breeding habitat of Pheasant-tailed Jacana should contain grass. For instance, at Banera pond there was no grass. There was only floating and submerged vegetations, namely *Trapa natans, Hydrilla verticillata* and *Ceratophyllum demersum.*

Table 6

DIFFERENCE BETWEEN THE FEEDING AREA OF THE BRONZEWINGED (N = 20) AND THE PHEASANT-TAILED (N = 14) IN TERMS OF COVER OF DIFFERENT AQUATIC VEGETATION DURING 1987-88

Types of	Bronze-winged	Pheasant-tailed	Mann-Witney U Test	
vegetation	Mean	Mean	U-value	P*
FLOVEGWLL	15.725	8.429	207.5	0.014
FLOVEGWSL	32.088	8.786	248.0	0.000
GR	0.200	21.321	9.0	0.000
OW	0.650	61.464	34.5	0.000
SUBVEG	65.100	0.000	273.0	0.000

*$P \leq 0.05$ is significant.
Note: FLOVEGWLL : Floating Vegetation with large leaves. FLOVEGWSL : Floating Vegetation with small leaves. GR: Grass. OW: Open Water. SUBVEG: Submerged Vegetation.

Predation: Predation pressure seems to be one of the factors deciding the timing of breeding season in jacanas. Both species complete their major breeding activities before the population of migratory raptors builds up in the area. There are 23 species of migratory raptors and they start arriving from September. Their number reaches a peak in December-January. Finishing the breeding activity before the build up of the raptor population was reported in resident ducks too (Sridharan 1989). Since the chicks of jacanas are precocial, this type of adjustment in the timing of breeding is highly significant in maintaining the population. Birds breeding late in the season were susceptible to predation, especially by marsh harrier.

Nest site competition: Potential competitors for the nesting habitat of the two species of jacanas appear to be purple moorhen *Porphyrio porphyrio* and kora *Gallicrex cinerea.* Among these, the population of kora was very low during the period of study and hence, the pressure from them was insignificant. Both the purple moorhen and kora breed in thick growth of *Paspalum distichum* (Lalitha Vijayan, pers. comm.). Competition if it does exist, can be only between the purple moorhen and

Pheasant-tailed Jacana. However, one nest of purple moorhen about 15 m away from a nest of Pheasant-tailed Jacana was sighted and this suggests that there was not much competition between these two species. The two species of jacanas not breeding inside the Park in the same year during the study period does not indicate competition between them. Rather, it indicates that their habitat requirements are different.

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POPULATION DYNAMICS IN SOME INDIAN BATS[1]

N. Badwaik[2]

Key words: population dynamics, bats

Four major factors control the population dynamics of bats. These are the breeding pattern, mortality, longevity and migratory habits. Breeding pattern can be divided into two main categories for purpose of population study, namely those which breed once a year and those which breed more than once a year or are continuous breeders. Each category can further be divided into monotocous species and polytocous species. Natural mortality can be due to genetically controlled factors as preferential male mortality, which occurs in nearly all species, or it can be due to other factors such as suckling habit, duration of suckling and load bearing capacity of the mother. Rarely, deaths occur due to accidents of different kinds. Unfortunately, there is almost no information about the longevity of Indian bats except about *Rousettus leschenaulti* and *Megaderma lyra lyra* which are definitely known to live for at least 15 years. Some species are seasonal migrators and exhibit some degree of sexual segregation. In such species, some idea of population dynamics can be deduced from only circumstantial evidence. Taking all these factors it is evident that there is a progressive increase in the population and dispersal of most species of common Indian bats.

Demographic study of animals involves a study in changes of population in time and space. Population growth is influenced by four major factors, namely breeding habits, fecundity, mortality and longevity. Spatial distribution involves migration, colonization and adaptation to new roosting sites. Since no study has been made so far on the population dynamics of Indian bats, I undertook such a study by random collection and examination of specimens of nine species of bats for six years from 5th April, 1981 to 4th March, 1987 in such a manner that all calendar months are represented by one collection or more. The geographical area of study included Maharashtra, Nimar region of Madhya Pradesh and Bangalore and Mysore districts of Karnataka. In addition I made use of the vast data in the voluminous and carefully preserved field diary and laboratory records maintained by Professor A. Gopalakrishna during the past five decades. The information regarding the number of specimens examined and data obtained from the diaries of Prof. Gopalakrishna is given in the Table 1.

The present report covers observations on *Rousettus leschenaulti, Cynopterus sphinx gangeticus, Taphozous longimanus, Megaderma lyra lyra, Hipposideros fulvus fulvus, Hipposideros speoris, Pipistrellus ceylonicus chrysothrix, Pipistrellus dormeri* and *Pipistrellus mimus mimus.* These species fall into two main categories on the basis of their breeding habits. The first category includes those species, which have a single annual breeding season, such as *Megaderma lyra lyra* (Ramaswamy 1960, Gopalakrishna and Badwaik 1989), *Hipposideros fulvus fulvus* (Madhavan *et al.* 1978) and *Pipistrellus ceylonicus chrysothrix* (Madhavan 1971). The precise season of breeding, however, varies among different species. While *Megaderma lyra lyra* and *Hipposideros fulvus fulvus* breed during October-November, *Pipistrellus ceylonicus chrysothrix* breeds during June July. *Hipposideros speoris* also breeds once a year, but the actual season varies in different parts of peninsular India (Gopalakrishna *et al.* 1991, 1992). *Rousettus leschenaulti* and *Cynopterus sphinx gangeticus* bring forth two litters in quick succession in an extended annual breeding season (Gopalakrishna and Choudhari 1977, Sandhu 1984). The second category includes species such as *Taphozous longimanus* (Gopalakrishna 1954, 1955), *Pipistrellus dormeri* (Madhavan 1978) and *Pipistrellus mimus mimus* (Gopalakrishna *et al.* 1975), which breed throughout the year and bring forth several litters in the year. (The terms 'monoestrous' and 'polyestrous' are employed

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[1] Accepted January, 1994.

[2] Department of Zoology, Institute of Science, Nagpur, 440 001, India.

Table 1

NUMBER OF SPECIMENS EXAMINED

(Numbers in brackets are taken from Prof. A. Gopalakrishna's diaries and laboratory records).

No.	Name of species	Number of specimens		
		Males	Females	Total
1.	*Rousettus leschenaulti*	262 (608)	341 (759)	603 (1367)
2.	*Cynopterus sphinx gangeticus*	132 (279)	152 (322)	284 (601)
3.	*Taphozous longimanus*	15(50)	39 (135)	54 (185)
4.	*Megaderma lyra lyra*	192 (910)	281 (1280)	473 (2180)
5.	*Hipposideros fulvus fulvus*	59 (204)	131 (418)	190 (622)
6.	*Hipposideros speoris*	55 (411)	115 (900)	170(1311)
7.	*Pipistrellus ceylonicus chrysothrix*	58 (420)	136 (970)	194 (1390)
8.	*Pipistrellus dormeri*	32 (188)	85 (485)	117 (673)
9.	*Pipistrellus mimus mimus*	32 (269)	82 (648)	114 (917)

in this report to indicate species which breed once a year and species which breed more than on ce ayear respectively — Kunz and Gustafson 1983).

On the basis of fecundity bats can be classified as monotocous and polytocous species depending on whether a single young or more than one young is delivered each time. While most species are monotocous, *Pipistrellus ceylonicus chrysothrix* and *P. mimus mimus* deliver two and rarely three young ones in each litter and 34% of *Pipistrellus dormeri* deliver two and the rest one young each time (Badwaik *et al.* 1992).

Mortality also can be considered under two categories apart from accidental deaths, which are rare. First, the predictable, nearly universal preferential male mortality during the post-weaning pre-pubertal phase of life. Gopalakrishna and Badwaik (1993) reported that, while the sex ratio is even at birth in all the species, the adult sex ratio is highly female dominant except in the case of *Taphozous melanopogon* (Abdulali 1949, Sapkal and Khamare 1984), in which the males were reported to outnumber the females. Secondly, infant mortality, which occurs in varying degrees in all the species depends on three factors, namely breeding habits, number of young ones delivered each time and roosting habits. In an earlier study Badwaik *et al.* (1992) showed that juvenile mortality was lowest among monoestrous monotocous bats such as *Megaderma lyra lyra* and *Hipposideros fulvus fulvus* (11.4% and 12.3% respectively), whereas it was highest among polyestrous polytocous species such as *Pipistrellus dormeri* and *Pipistrellus mimus mimus* (58.7% and 59.5% respectively). In polyestrous monotocous species like *Taphozous longimanus* and monoestrous polytocous species like *Pipistrellus ceylonicus chrysothrix* infant mortality was mid-way between the above mentioned extremes (17.9% and 45.4% respectively). We argued that the more times the species breeds in a year and the greater the number of young delivered during a cycle the higher is the juvenile mortality. Due to their peculiar diurnal roosting habits in dark natural caves, in the hollows in trees or in the dark recesses of man-made structures such as dungeons in old forts, temples, etc., and due to their nocturnal foraging activity, they have no natural predators, and any such predation is due to chance encounter. Deaths due to accidents are also rare.

Longevity has a direct relationship to population growth. Unfortunately there is no record on the longevity of any Indian species except for the accidental discovery of juveniles and adult banded specimens of *Rousettus leschanaulti* and *Megaderma lyra lyra* 15 years after banding (Badwaik 1992) thereby indicating that these species have a longevity of at least 16 years. On this basis the rate of growth of population of *Rousettus leschenaulti* was shown to be at least 1.3% to 1.5% per annum (Gopalakrishna and Badwaik 1993). Following a similar calculation the growth rate of *Megaderma lyra lyra* comes to 0.7% per annum. Bats have a longer life than other mammals of comparable size (Hill and Smith 1985, Gopalakrishna and Badwaik 1993). The recorded data indicate that the monoestrous monotocous bats live for a longer period than polyestrous polytocous species. A longevity of 15 to 30 years has been reported in some American and European species (Tuttle and Stevenson 1982, Sommers *et al.* 1993). There is no reason to assume that Indian bats have a lesser longevity than their cousins in Europe and America. While it is not possible to determine the exact rate of population growth in the Indian species for want of data concerning their longevity, circumstantial evidence suggests that there may be a progressive increase of the population of the other species too. Natural caves and hollows in trees were the normal original roosts of the bats. But bats have adapted themselves to a variety of other roosting sites such as crevices in rocks (*Taphozous kacchensis*), cavity in the internodes of bamboo stem (*Tylonycteris pachypus*), within whorls of banana leaves (*Kerivoula picta*) and an unending variety of man-made structures like tunnels (*Rhinolophus rouxi*), temples (*Hipposideros fulvus fulvus, Taphozous melanopogon*), dungeons of old forts (*Rhinopoma microphyllum kinneari, Taphozous melanopogon*), cowsheds (*Taphozous longimanus, Megaderma lyra lyra, Hipposideros speoris*), between tiles in roof of human habitations and within crevices in the wooden frame work of buildings (several species of pipistrelles) (personal observations). In most cases these new roosts are, evidently, adopted by the bats to accommodate the spill-over specimens from their natural roosts due to increased population pressure beyond the bearing capacity of their natural roosts. Their adaptibility to new roosts appears to be phenomenal with the result that almost all kinds of structures are inhabited by bats.

Migratory habits play an important role in the dispersal of some species of bats. Some species have been shown to be seasonal migrators and to colonize in different places during different seasons (Gopalakrishna 1986, Badwaik 1991). New colonies are, thus, formed in places far off from their original colonies. This is, probably, the reason why many Indian species have a wide distribution. Their flying habits facilitates dispersal.

The foregoing account reveals that in all the species studied here there is a progressive increase in the population necessitating the dispersal of the spill-over population which form new colonies and adapt to new habitats. Perhaps, the abundance of insects throughout the year and the presence of numerous natural caves and man-made habitats suitable for roosting of bats in addition to the warm weather throughout the year and occurrence of tropical rain forests are conducive to the progressive increase in the population of most species of bats in India. However, only extensive banding of bats and the study of banded specimens during the following years will give an accurate picture of population dynamics of these unique mammals.

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ON THE CHARACTERISTICS OF PUPAL CASE, ADULT AND EGG OF INDIAN SPECIES OF *LIPALEYRODES* TAKAHASHI (ALEYRODIDAE: HOMOPTERA) WITH DESCRIPTION OF A NEW SPECIES[1]

B. Vasantharaj David[2] and K. Thenmozhi[3]

(*With four text-figures*)

Key words: *Lipaleyrodes vernoniae,* Aleyrodidae

Four species of *Lipaleyrodes* Takahashi from India were studied for the characteristics of the pupal case, egg and adults to understand their significance in aleyrodid taxonomy. Among the four species one species from *Vernonia cinerea* (Compositae) has been described as a new species, namely *Lipaleyrodes vernoniae.* No difference was observed in the structure of egg in the species studied. However, in the adults the compound eyes are joined by a single ommatidium as in *Bemisia tabaci,* that suggesting probably Bemisini and Lipaleyrodini share this characteristic feature at the tribal level. The study indicates that at species level variations in the number of setae in meso- and metatibial brush and in the metatibial comb, and the pattern of distribution of setae on the paramere may play significant role in species determination.

INTRODUCTION

In 1962 Takahashi erected the genus *Lipaleyrodes* characterised mainly by submarginal area being distinctly defined by a dorsal disc with wax plates in large clusters arranged in a row. Mound and Halsey (1978) reported a new combination *Lipaleyrodes breyniae* for *Trialeurodes breyniae* which was described in 1931 by Singh on *Breynia vitis-idaea* (Burm. f.) Fischer [=*Breynia rhamnoides* (Retz.)] from India. However, David and Subramaniam (1976) added two new species, namely *L. crossandrae* and *L. euphorbiae* from India and presented a key for Indian species of *Lipaleyrodes.* Jeritta and David (1986) reported the occurrence of *L. euphorbiae* on *Phyllanthus amarus* Schum. and Thonn. (=*Phyllanthus niruri*) and *P. maderaspatensis* L. from India and briefly indicated the life history of the species. In 1990 specimens of *Lipaleyrodes* infesting *Phyllanthus* sp. and *Euphorbia* sp. were received from the ICAR Research Complex at Port Blair in Andaman and Nicobar Islands.

Presently aleyrodid taxonomy is based entirely on the so-called "Pupal case" and little is known about the morphology and characteristic features of the egg and adults, particularly the male genitalia of Indian aleyrodids excepting for the contribution of Singh (1931) in respect of a few species. No serious attempt has been made so far to relate the characteristic features of the egg and adult with that of the pupal case in aleyrodid taxonomy and the need for such an approach has been stressed recently by Gill (1990). Esther (1991) made a preliminary study of the pupal case, egg and adult morphology of a few species in relation to aleyrodid taxonomy. The present paper deals with a detailed comparative study of the egg and adult characteristics with that of the characteristic features of pupal case of the Indian species of the genus *Lipaleyrodes* Takahashi.

MATERIALS AND METHODS

Material: This study was based on the various species of *Lipaleyrodes* collected by us and also examination of the type species of *Lipaleyrodes breyniae* (Singh).

Methods: *Egg*: Eggs were removed from the leaf surface by means of a fine needle and transferred to lactic acid and examined under a stereoscopic binocular microscope. Such eggs were stored in lactic acid for three to four days till they became transparent. The eggs were then transferred to polyvinyl lactophenol on a slide. A cover glass was

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[1] Accepted October 1993.

[2] Jai Research Foundation, Valvada P.O. 396108, Valsad, Gujarat.

[3] Fredrick Institute of Plant Protection and Toxicology, Padappai 601 301, Tamil Nadu, India.

placed carefully to avoid air bubbles and slides were allowed to dry before observations.

Pupal case: In the preparation of permanent mounts of the pupal cases, the method suggested by Jesudasan and David (1991) was adopted.

Adult: To study the adult characteristics the method suggested by Mound (1965) was followed. Adults taken dry from stored leaves or collected live were placed in solution containing ethyl alcohol 5 parts, lactic acid 1 part and distilled water 4 parts. The specimens were then transferred to a stronger solution (ethyl alcohol 35 parts, lactic acid 35 parts and distilled water 30 parts) for 4 to 5 days. In the case of fresh specimens it may be kept for a day. Finally they were transferred to the preservative containing chloral hydrate 40 g, glycerine 20 CC and distilled water 40 CC. The adults were mounted in Berlese after first detaching the head, abdomen and wings so that all parts will be always present in the same slide. After mounting, the specimens were ringed with Euparal first, then with Murrayite or thin Canada Balsam. All observations, micromeasurements and camera lucida drawings of egg, pupal case and adults were made using Carl Zeiss LOBOVAL 4 microscope.

RESULTS

Specimens of *Lipaleyrodes* collected from various host plants were examined critically and the description of the various stages of the species studied has been provided. Key for the Indian species of *Lipaleyrodes* based on characteristics of male genitalia and metatibia of adult and pupal case has also been provided.

KEY TO INDIAN SPECIES OF *Lipaleyrodes* TAKAHASHI (BASED ON ADULT AND PUPAL CASE)

1. Setae on first abdominal segment wanting; each submarginal cluster with 4 or 5 wax plates; paramere with 4, 7 and 7 setae respectively on inner, mid and outer regions .... *breyniae* (Singh)
   Setae on first abdominal segment present 2
2. Wax plates in clusters polygonal or oval shaped; metatibial brush with 2 setae and comb with 12 or 14 setae 3
   Wax plates in clusters petal-like and irregular shaped; metatibial brush with 3 setae and comb with 11 setae .... *vernoniae* sp. nov.
3. Wax plates in clusters oval; metatibial comb with 12 setae; paramere with 4, 8 and 7 setae respectively on inner, mid and outer regions ..... *crossandrae* David & Subramaniam
   Wax plates in clusters polygonal; metatibial comb with 14 setae; paramere with 4,7 and 5 setae respectively on inner, mid and outer regions....*euphorbiae* David & Subramniam

Genus *Lipaleyrodes* Takahashi 1961

Lipaleyrodes Takahashi, 1962, *Proc. Ent. Soc., London (B)* 31:100.

Type species: *Lipaleyrodes phyllanthi* Takahashi 1962: by monotypy.

Pupal case ovate, margin crenulate, tracheal pores, clefts or combs wanting, not strongly sclerotized; submarginal area distinctly defined from dorsal disc, broad with wax plates in large clusters arranged in a row; dorsal setae discernible; abdominal segment VII shortened medially; vasiform orifice large, subcordate; operculum occupying over half the length of orifice; lingula knobbed, exposed with dorsal expanded part longer than wide.

1. **Lipaleyrodes breyniae** Singh

(Fig. 1, A-D)

Trialeurodes breyniae Singh, 1931, *Mem. Dep. Agric., India,* 12 (11): 49.

Lipaleyrodes breyniae (Singh), Mound and Halsey 1978, *Whitefly of the World,* p. 167.

Pupal case: Pupal case pale yellowish; found in groups on the undersurface of leaf with dense bluish white fluff composed of fleecy curled fine filaments of waxy secretion; 0.85 mm long and 0.65 mm wide.

Margin: Finely crenulate; paired anterior and posterior marginal setae evident, 10 µm long; thoracic and caudal combs and pores absent.

Dorsal surface: Dorsum with two pairs of dorsal setae; cephalic setae 50 µm long, VIII abdominal setae laterad of vasiform orifice, 62.5 µm long; I abdominal setae wanting; caudal setae submarginal, 85 µm long. Abdominal segment VI, 37.5 µm long; segment VIII longest, 55 µm long; segment VII medially shortened, 5 µm long. Dorsal disc separated from submargin by a distinct line. Submargin broad with 11 pairs of clusters of wax plates, each cluster consisting of 4 to 5 oval shaped wax plates (Fig 1, B).

Vasiform orifice little longer than wide, 87.5 µm long and 77.5 µm wide; operculum 55 µm long and 37.5 µm wide. Lingula large, exposed, setose, bearing a pair of setae sub-apically.

Ventral surface: A pair of ventral abdominal setae present, 12.5 µm long and 37.5 µm apart. Antenna does not extend beyond base of prothoracic leg. Setae at base of legs and rostrum wanting.

Materials examined: 3 specimens on *Breynia rhamnoides*: INDIA: Bihar, Pusa, 11.4.1929, K. Singh (In the collections of Division of Entomology, IARI, New Delhi); 8 specimens on *Indigofera cassiodes,* Rottler ex DC. Bangalore, 6.5.93, K. Thenmozhi.

Hosts: *Breynia vitis-idaea (=Breynia rhamnoides)* (Euphorbiaceae), *Indigofera cassiodes* (Papilionaceae).

Distribution: INDIA: Pusa (Bihar), Bangalore (Karnataka). Reported for the first time from South India.

The description of the egg and adults provided here are based on that of Singh (1931).

Egg: (Fig. 1, C): Measures 0.19 mm long and 0.095 mm wide; sub-oval in outline with smooth surface; laid on under surface of leaf generally arranged in the form of circle.

ADULT MALE: Length from vertex to tip of claspers 1.03 mm; pale yellowish with a light orange tinge; eyes crimson, divided. *Antenna*: Seven segmented; II segment sub-pyriform, hairy, 0.046 mm; III sub-cylindric, imbricate 0.085 mm, armed with two primary sensoria and the sensorial cone near the distal end; IV sub-cylindric, 0.019 mm; V sub-cylindric, 0.023 mm long with a primary sensorium apically; VI sub-cylindric, 0.023 mm with a small sensorial cone apically; VII sub-fusiform, hairy with a primary sensorium and a sensorial cone in the distal half and a setae on the tip of the segment. *Wings:* Forewing hyaline, immaculate, not mottled, 0.85 mm long and 0.28 mm wide; radius as a smooth flexure and cubitus as a streak. Hind wing 0.76 mm long and 0.25 mm wide; radius as a smooth flexure. *Legs:* Hind tibia 0.304 mm long with ordinary rows of spines; proximal tarsus 0.095 mm; distal tarsus 0.076 mm. *Genitalia:* (Fig. 1, D): Parameres 0.031 mm at base, 0.086 mm long; slightly narrowing distally and the sharp pointed tip incurved called apical spine. Aedeagus cylindric at base, tapering distally, shorter than clasper.

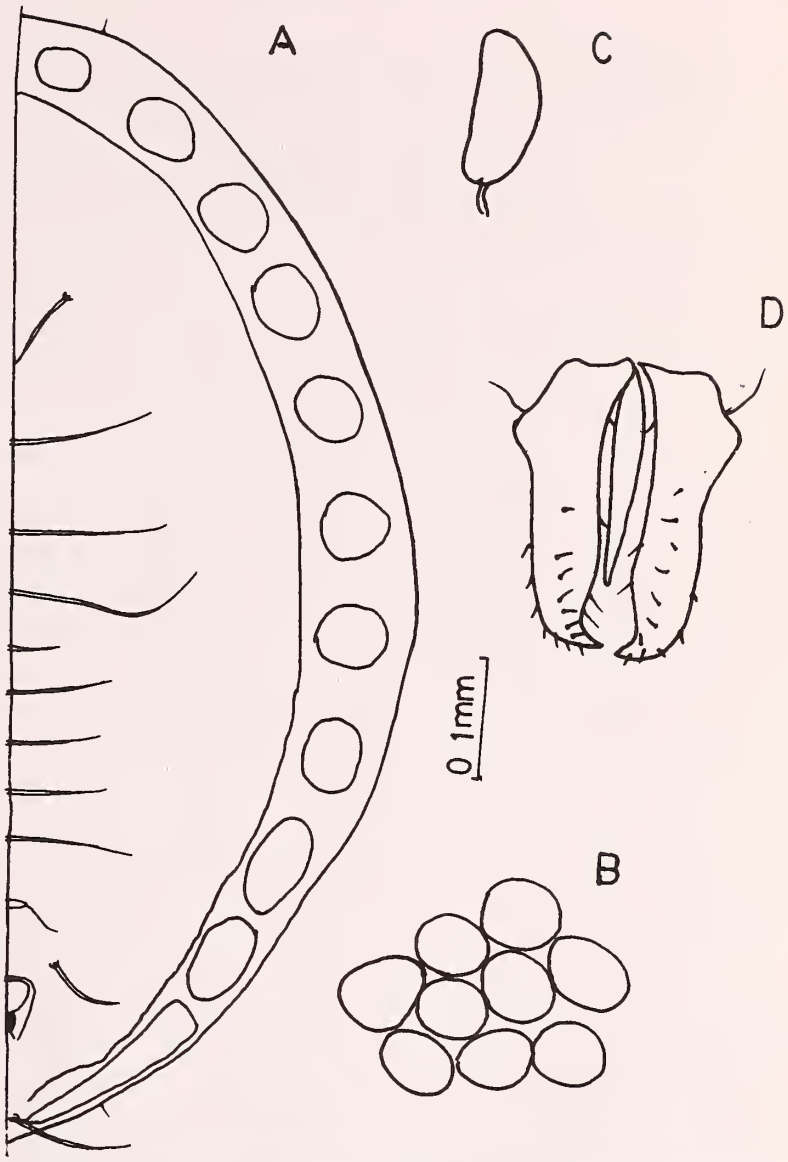


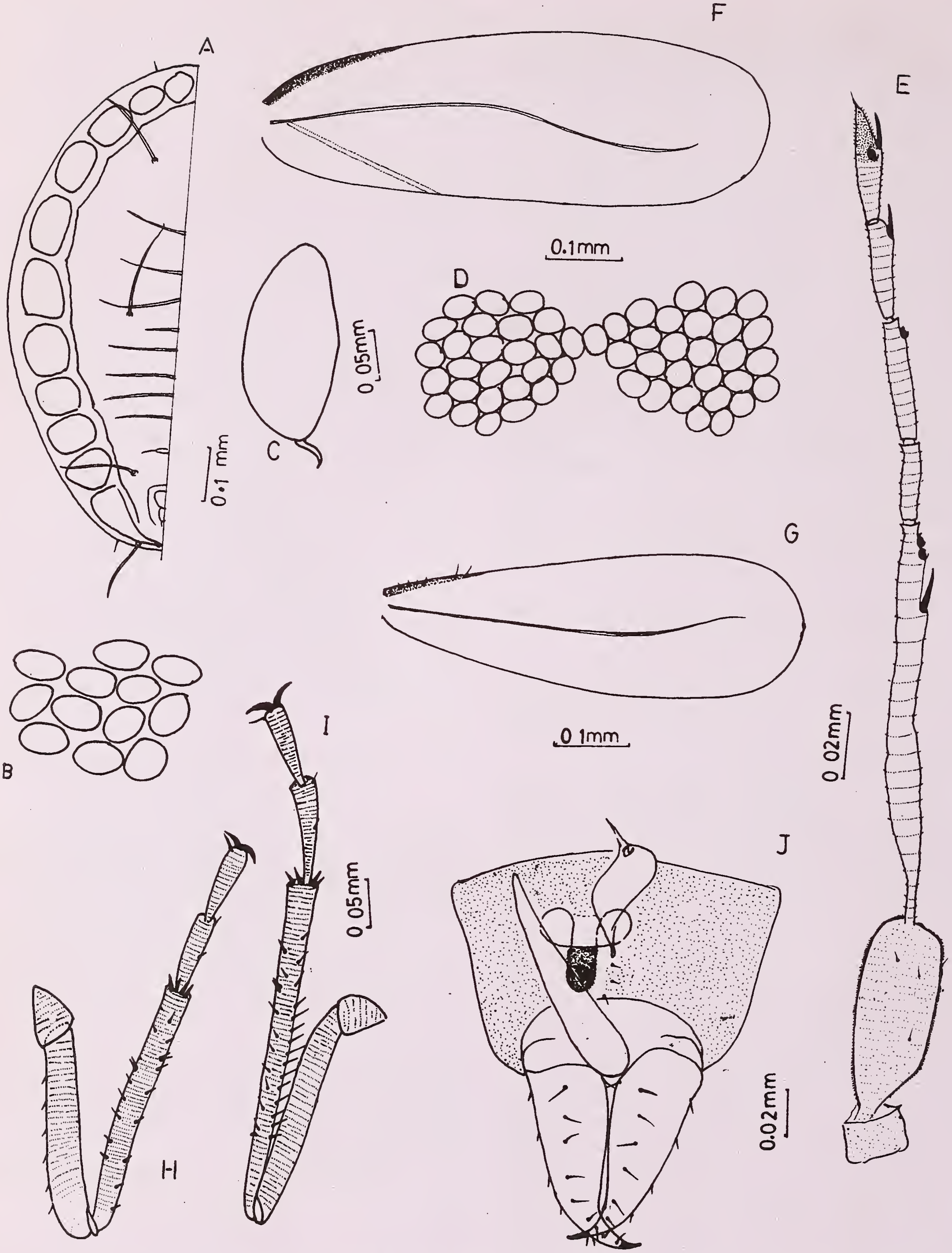
Fig. 1. *Lipaleyrodes breyniae* Singh: A. Pupal case; B. Cluster of wax plates; C. Egg; D. Male genitalia.

FEMALE: Body length meaures from vertex to tip of ovipositor 1.1 mm. *Antenna:* Seven segmented as in male, length being (in mm) II, 0.046; III, 0.101; IV, 0.023; V, 0.031; VI, 0.028; VII, 0.039. *Wings:* Forewing 0.95 mm long and 0.38 mm wide. Hind wing 0.85 mm long and 0.31 mm wide. *Legs:* Hind tibia 0.342 mm; proximal tarsus 0.095 mm; distal tarsus 0.076 mm.

2. **Lipaleyrodes crossandrae** David and Subramaniam
(Fig. 2, A-J)

Lipaleyrodes crossandrae David and Subramaniam, 1976, *Rec. Zool. Surv., India.* 70:201.

Pupal case: Found in groups on under surface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D
0.05mm
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G
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0.02mm

Fig. 2. *Lipaleyrodes crossandrae* David & Subramaniam: A. Pupal case; B. Cluster of wax plates; C. Egg; D. Compound eyes joined by single ommatidium; E. Antenna of male; F. Forewing of male; G. Hindwing of male; H. Mesothoracic leg of male, I. Metathoracic leg of male, J. Male genitalia.

of leaves in dense white fluff of fleecy curled filaments of wax. Pupal case white in colour, oval shaped, length 0.58-0.78 mm and width 0.41-0.50 mm.

Dorsal surface: Dorsum with three pairs of setae, long and quite characteristic; cephalic setae 100 µm - 127 µm long; I abdominal setae 146 µm - 160 µm long and VIII abdominal setae laterad to base of vasiform orifice, 88 µm - 125 µm long. Caudal setae submarginal, 80 µm - 110 µm long. Abdominal segment VI 37.5 µm long; segment VII, 5 µm long, medially shortened; segment VIII longest, 45 µm long. Dorsal disc separated from submargin by a distinct line. Submargin broad with 11 pairs of clusters of wax plates; each cluster consisting of 8-17 oval shaped wax plates (Fig. 2, B).

Vasiform orifice bluntly pointed at caudal end; 47 µm long and 52 µm wide with lateral ridges. Operculum wider than long, 28 µm long and 39 µm wide. Lingula large, more or less club shaped, setose, exposed, bearing a pair of long setae sub-apically, included.

Ventral surface: A pair of ventral abdominal setae, 36 µm long and 28 µm apart. Setae at the base of legs and rostrum wanting.

Materials examined: Holotype and 13 paratypes on *Crossandra undulaefolia.* INDIA: Tamil Nadu, Coimbatore, 15.11.1966. B.V. David; 7 pupal cases on *Achyranthes aspera* L., Tamil Nadu, Padappai, 28.7.92, K. Thenmozhi; 8 Pupal cases on unidentified Acanthaceae, Padappai, 7.6.1993, K. Thenmozhi; 10 pupal cases on *Blepharis maderaspatensis,* Coimbatore, 5.8.93, K. Thenmozhi.

Hosts: *Crossandra undulaefolia, Blepharis maderaspatensis* (Acanthaceae); *Achyranthes aspera* (Amaranthaceae).

Distribution: INDIA: Coimbatore, Padappai (Tamil Nadu).

Egg: In the case of *Achyranthes aspera* the egg is found on under surface of leaf mainly on either side of midrib deposited with powdery wax. Egg measures 0.2 mm long and 0.11 mm wide, pedicel measures 0.03 mm attached to leaf surface (Fig. 2, C). In *Blepharis maderaspatensis* female lays eggs on under surface of leaf deposited along with wax. Egg measures 0.2 mm long and 0.11 mm wide. In unidentified host plant eggs are laid on both surfaces of leaf deposited along with powdery wax. The egg measures 0.2 mm long and 0.12 mm wide and pedicel 0.03 mm.

ADULT MALE: Body light yellow in colour, legs and antennae pale, wings hyaline, eyes maroon, constricted in the middle and joined by a single ommatidium (Fig. 2, D). Body length from vertex to tip of abdomen 1.11 mm. *Antenna*: (Fig. 2, E): Seven segmented; I 0.017 mm long; II sub-pyriform, 0.055 mm long; III sub-cylindric, imbricate, longest, 0.125 mm long with two primary sensoria and a sensorial cone at distal end; IV sub-cylindric, 0.022 mm long; V club shaped, 0.037 mm long with a primary sensorium apically; VI, sub-cylindric, 0.020 mm with a sensorial cone sub-apically; VII sub-fusiform, hairy, 0.035 mm long having a primary sensorium and a sensorial cone in the middle of the segment and a seta at the tip. *Wings*: (Fig. 2, F-G): Forewing 0.75 mm long and 0.18 mm wide, immaculate, not mottled, hyaline and transparent; radius as a smooth flexure and cubitus as a streak. Hindwing 0.65 mm long and 0.18 mm wide, hyaline, not mottled; radius as a smooth flexure. *Legs*: Mesotibia (Fig. 2, H): 0.22 mm long with two mesotibial brush consisting of 2 setae each. Proximal tarsus 0.07 mm long and distal tarsus 0.06 mm long, end with claws and a seta. Metatibia (Fig. 2, I) 0.30 mm long. Metatibial comb consisting of 12 setae and a brush with 2 setae. Proximal tarsus 0.08 mm long and a distal tarsus 0.07 mm ending with claws and a seta. *Genitalia*: (Fig. 2, J): Parameres 0.11 mm long and 0.022 mm wide, wider in the basal part and tapering apically forming an apical spine. The inner margin of paramere has 4 setae, outer margin 7 setae, and the mid region with 8 setae. Aedeagus 0.1 mm long and 0.007 mm wide, broad at base and bluntly tapering at the distal end.

FEMALE: Body length from vertex to tip of ovipositor, 1.290 mm. *Antenna:* Seven segmented, I 0.017 mm, II 0.06 mm, III 0.135 mm, IV 0.022 mm, V 0.037 mm, VI 0.035 mm and VII 0.037 mm. The primary sensorium and a sensorial cone as in male.

Wings: Forewing 0.90 mm long and 0.22 mm wide. Hindwing 0.76 mm long and 0.21 mm wide. *Legs*: Mesotibia 0.24 mm long, proximal tarsus 0.06 mm long and distal tarsus 0.07 mm long. Mesotibia 0.33 mm long, proximal tarsus 0.07 mm long and distal tarsus 0.07 mm long. Mesotibial brush, metatibial comb and brush as in male.

3. **Lipaleyrodes euphorbiae**
David and Subramaniam
(Fig. 3, A-J)

Lipaleyrodes euphorbiae David and Subramaniam, 1976, *Rec. Zool. Surv., India,* 70:202.

Pupal case: Pupal case found in groups on undersurface of leaf and to a limited extent on upper surface also with dense bluish white fluff of fleecy curled filaments of wax. Body white, oval 0.71-0.78 mm long and 0.51-0.60 mm wide.

Margin: Finely crenulate, paired anterior and posterior marginal setae, 5 µm and 11 µm long respectively. Thoracic and caudal tracheal pores and combs absent.

Dorsal surface: Three pairs of dorsal setae: cephalic setae 12.5 µm-140 µm long; I abdominal setae minute, 7.5 µm-11 µm long, in *Phyllanthus maderaspatensis* measures 137.5 µm long; VIII abdominal setae laterad of base of vasiform orifice, 80-105 µm long. Caudal setae 80 µm-110 µm long. Abdominal segments distinct, pockets well developed and contiguous, abdominal segment VI 55 µm; VII medially short, 5 µm: VIII longest 55 µm.

Dorsal disc separated from submargin by a distinct line. Submargin broad with 11 pairs of clusters of wax plates each cluster consisting of 5 to 16 polygonal shaped wax plates (Fig. 3, B). Eight pairs of minute setae present in the sub-dorsal area, 4 on cephalic region and 4 on posterior part of abdominal region.

Vasiform orifice bluntly pointed at caudal end, a little wider than long; width 61 µm and length 58 µm; lateral ridges distinct. Operculum wider than long, 30 µm long and 47 µm wide; lingula large, more or less club shaped, exposed bearing a pair of long setae sub-apically, included but sometimes extended beyond posterior margin of orifice.

Ventral surface: A pair of ventral abdominal setae cephalad of base of vasiform orifice 8 µm long, 25 µm apart. A minute pair of setae present at base of rostrum and legs.

Materials examined: Holotype and 17 paratypes on *Euphorbia prostrata.* INDIA: Tamil Nadu, Madurai, 28.1.1967, B.V. David; 4 pupal cases on *Phyllanthus maderaspatensis,* Tamil Nadu, Padappai, 1.7.1992, K. Thenmozhi; 3 pupal cases on *Phyllanthus amarus,* Tamil Nadu, Padappai, 1.7.1992, K. Thenmozhi; 10 pupal cases on *Phyllanthus acidus,* Tamil Nadu, Padappai, 8.3.1993, K. Thenmozhi; 2 pupal cases *Euphorbia* sp., Port Blair, 11.1.1990, Coll. C.R. Ramesh; 2 pupal cases *Phyllanthus* sp., Port Blair, 11.1.1990, coll. C.R. Ramesh.

Host: *Euphorbia prostrata, Phyllanthus maderaspatensis, P. amarus (=niruri), P. acidus* (Euphorbiaceae). *Phyllanthus acidus* is a new host record for this species.

Distribution: INDIA: Tamil Nadu (Padappai, Madurai); Karnataka (Bangalore); Andaman and Nicobar Islands (Port Blair).

Egg: In *Euphorbia prostrata* eggs are laid on under surface deposited with waxy secretion. In *Phyllanthus maderaspatensis* (Fig. 3, C) and *P. amarus* the female lays eggs on both surfaces of the leaf. Before egg laying the female deposits wax powder on the leaf surface and then lays eggs in a scattered manner. Freshly laid eggs are pale cream and later turn dark brown. The egg measures 0.2 mm long and 0.11 mm wide, pedicel 0.003 mm long. In *P. acidus* the female deposits powdery wax in a circular ring and then starts egg laying in the same manner. Egg measures 0.19 mm long and 0.11 mm wide; pedicel 0.003 mm long.

ADULT MALE: Body light yellow, head and thorax light brown, abdomen, antennae and legs pale; wings hyaline and eyes maroon, constricted in the middle and joined by a single ommatidium (Fig. 3, D). Body from vertex to tip of abdomen measures 1.11 mm. *Antenna:* (Fig. 3, E): Seven segmented; I broader than long, 17.5 µm x 135 µm; II sub-pyriform, hairy, longer than wide, 45 µm x 25 µm;

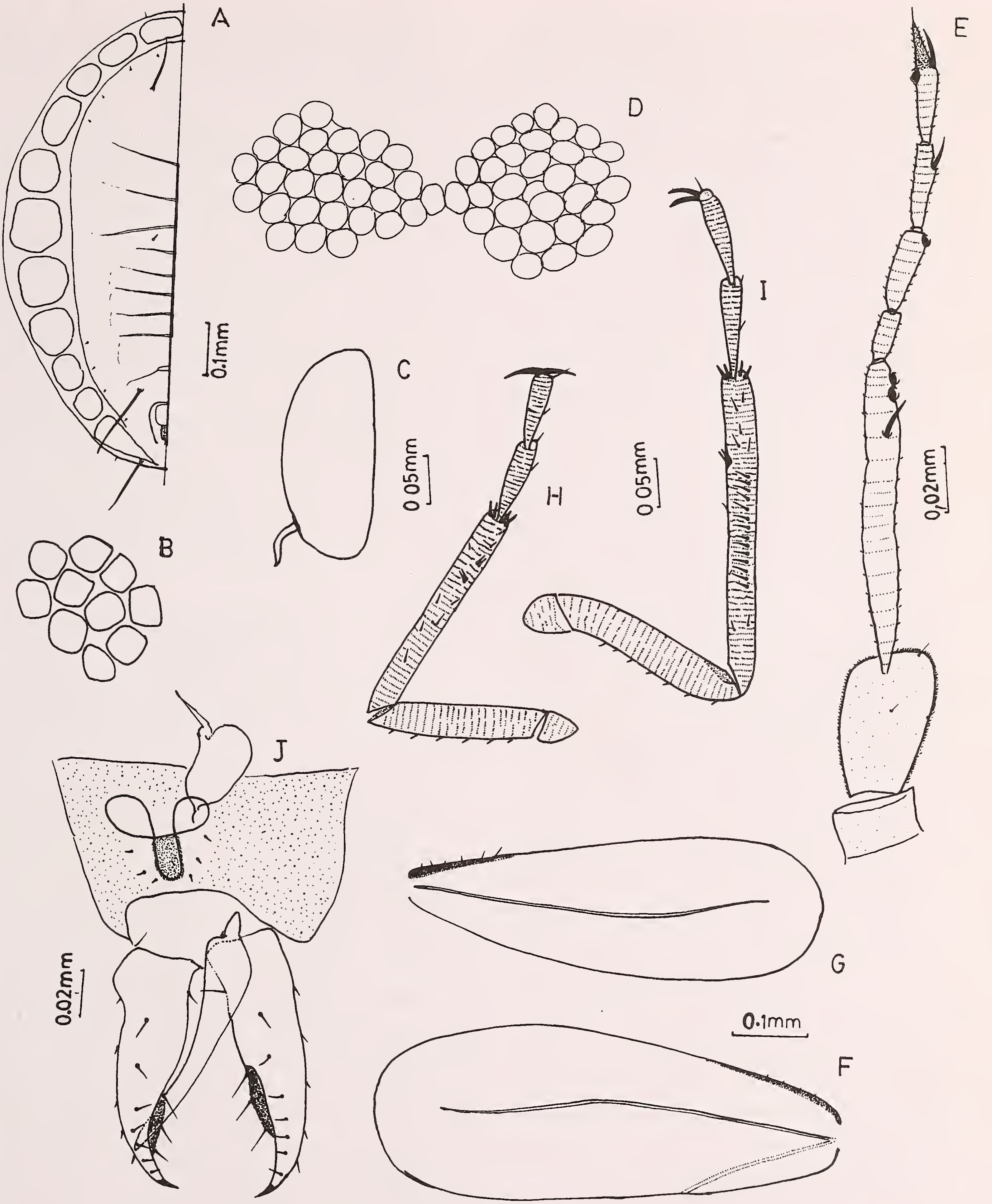
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Fig. 3. *Lipaleyrodes euphorbiae* David & Subramaniam: A. Pupal case; B. Cluster of wax plates; C. Egg; D. Compound eyes joined by single ommatidium; E. Antenna of male; F. Forewing of male; G. Hindwing of male; H. Mesothoracic leg of male; I. Metathoracic leg of male; J. Male genitalia.

III sub-cylindric, imbricate, longest, 110 µm with two primary sensoria and a sensorial cone sub-apically; IV sub-cylindric, 17.5 µm long; V club shaped, broader apically and slightly narrow in the basal part, 30 µm long with a primary sensorium apically; VI sub-cylindric, 25 µm long with a sensorial cone sub-apically; VII sub-fusiform, 30 µm long with a primary sensorium and a sensorial cone in the middle and a seta at the tip. *Wings*: (Fig. 3, F): Forewing 0.72 mm long and 0.22 mm wide, not mottled, hyaline, immaculate; radius as a smooth flexure and cubitus as a streak. Hindwing (Fig. 3, G) 0.64 mm long and 0.20 mm wide; radius as a smooth flexure. *Legs*: Mesotibia (Fig. 3, H) 0.24 mm long with 2 mesotibial brush consisting of 2 setae; proximal tarsus 0.07 mm long and distal tarsus 0.06 mm long ending with claws and a seta. Metatibia (Fig. 3, I) 0.31 mm long with metatibial comb consisting of 14 setae and a brush consisting of 2 setae. Proximal tarsus 0.09 mm long and distal tarsus 0.07 mm long. *Genitalia*: (Fig. 3, J): Paramere 0.107 mm long and 0.02 mm wide. Inner margin of paramere consisting of 4 setae, one at basal end and 3 at inflatable sac. The outer margin has 5 setae and the mid region 7 setae. Paramere broader at distal end and tapering at apical end forming an apical spine. Aedeagus 0.10 mm long and 0.077 mm wide, broader at the base and tapering at apical end.

FEMALE: Body from vertex to tip of ovipositor 1.20 mm. *Antenna:* Seven segmented: I 0.02 mm, II 0.057 mm, III 0.11 mm, IV 0.017 mm, V 0.035 mm, VI 0.027 mm and VII 0.04 mm. Primary sensorium and sensorial cone present as in male. *Wings*: Forewing 0.92 mm long and 0.32 mm wide; hindwing 0.69 mm and 0.27 mm wide. *Legs*: Mesotibia 0.25 mm long, proximal tarsus 0.092 mm long and distal tarsus 0.087 mm long. Metatibia 0.31 mm long, proximal tarsus 0.11 mm long and distal tarsus 0.11 mm long. Mesotibial brush, metatibial comb and brush as in male.

4. **Lipaleyrodes vernoniae** sp. nov.

(Fig. 4, A-I)

Pupal case: White, oval, found in groups on under surface of leaves with a dense white fluffy and fleecy curled filaments of wax. Body length 0.810 mm and width 0.520 mm.

Margin: Margin finely crenulate. Paired anterior and posterior marginal setae respectively 10 µm and 25 µm long.

Dorsal surface: Dorsum with three pairs of dorsal setae: cephalic 100 µm, I abdominal 75 µm, VIII abdominal laterad of base of vasiform orifice 95 µm. Caudal setae submarginal 105 µm. Abdominal segment VI 37.5 µm, VIII 55 µm and VII medially shortened. Dorsal disc separated from submargin by a distinct line. Submargin 80 µm broad with 11 pairs of clusters of wax plates, each cluster consisting of 6-11 petal-like irregular shaped wax plates (Fig. 4, B).

Vasiform orifice bluntly pointed at caudal end, 90 µm long and 75 µm wide. Operculum wider than long, 55 µm x 40 µm. Lingula large, exposed, setose, bearing a pair of long setae sub-apically.

Ventral surface: A pair of ventral abdominal setae 25 µm long and 37.5 µm apart. Setae at base of rostrum and legs wanting.

Materials examined: Holotype 1 pupal case, on *Vernonia cinerea*. INDIA: Padappai, 21.1.93; K. Thenmozhi. *Paratypes:* 9 pupal cases on slides bearing same data; one pupal case bearing the same data in the collection of the Division of Entomology, IARI, New Delhi.

Host: *Vernonia cinerea* (Compositae).

Distribution: INDIA: Tamil Nadu (Padappai).

Egg: Eggs are laid near basal part of under surface of leaf deposited with powdery wax. Freshly laid eggs are cream coloured and later change to dark brown. Egg 0.19 mm long and 0.10 mm wide, sub-oval with smooth surface (Fig. 4, C).

ADULT MALE: Body pale yellow, wings hyaline, eyes maroon, divided and joined by single ommatidium (Fig. 4, D). Body from vertex to tip of abdomen 1.08 mm. *Antenna*: (Fig. 4, E): Seven segmented; I 0.017 mm long and 0.032 mm wide; II sub-pyriform, hairy, 0.052 mm long and 0.032 mm wide; III sub-cylindric, imbricate, longest, 0.12 mm long with two primary sensoria and a sensorial cone sub-apically, IV 0.03 mm long, V club-shaped, 0.035 mm long with a primary sensorium apically; VI cylindric, 0.025 mm long with a sensorial cone

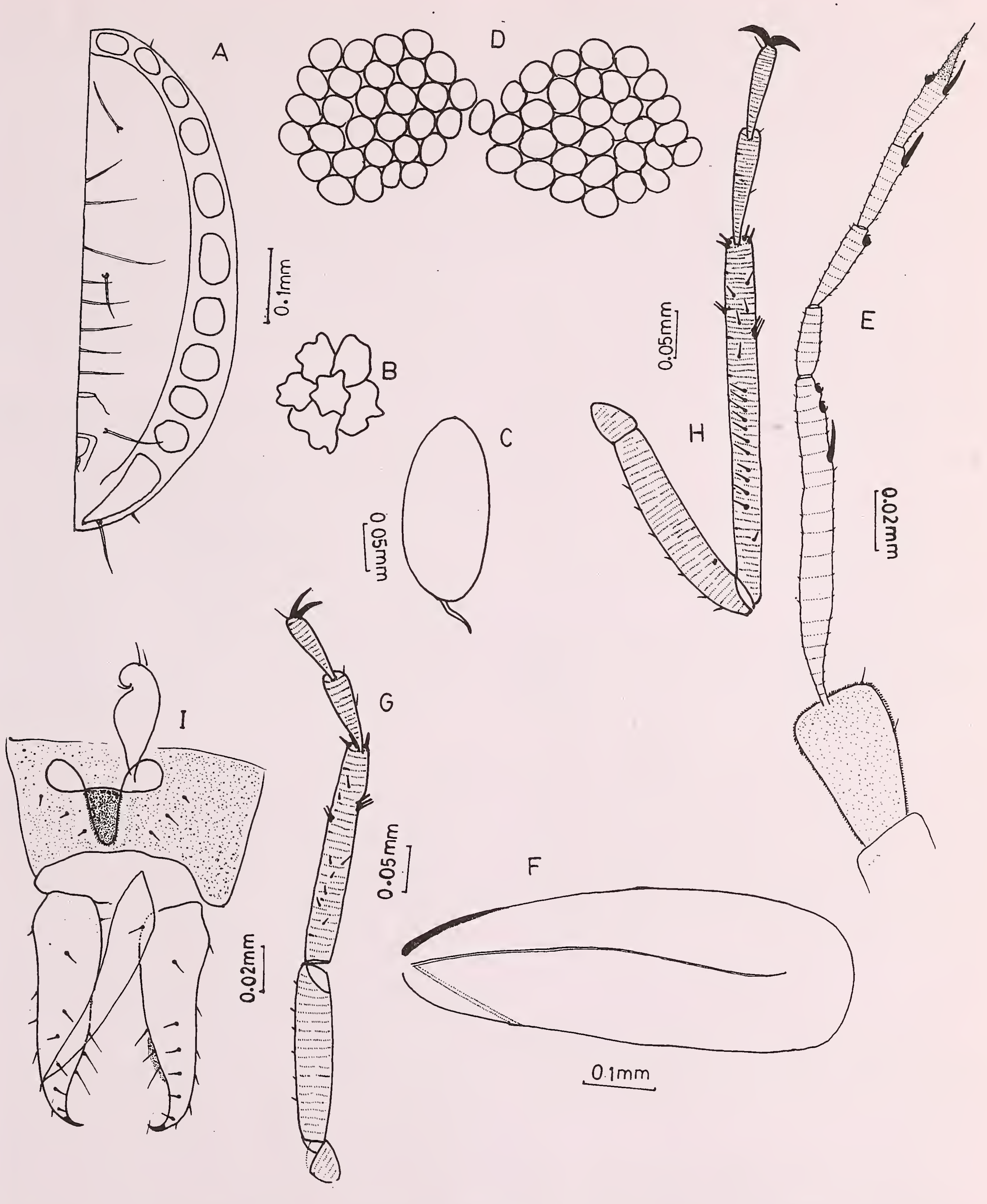
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Fig. 4. *Lipaleyrodes vernoniae* sp. nov.: A. Pupal case; B. Cluster of wax plates; C. Egg; D. Compound eyes joined by single ommatidium; E. Antenna of male; F. Forewing of male; G. Mesothoracic leg of male; H. Metathoracic leg of male; I. Male genitalia.

subapically; VII sub-fusiform, 0.035 mm long with a primary sensorium and a sensorial cone in the middle of the segment and a seta at tip. *Wings* (Fig. 4, F): Forewing 0.91 mm long and 0.21 mm wide, not mottled, hyaline, immaculate, radius as a smooth flexure and cubitus as a streak. Hindwing 0.61 mm long and 0.16 mm wide; radius as a smooth flexure. *Legs*: Mesotibia (Fig. 4, G) 0.22 mm long, two mesotibial brushes consisting of 3 and 2 numbers of setae; proximal tarsus 0.07 mm long and distal tarsus 0.06 mm ending with claws and a seta. Metatibia (Fig. 4, H) 0.31 mm long, metatibial comb consisting of 11 setae and a brush consisting of 3 setae; proximal tarsus 0.08 mm long and distal tarsus 0.07 mm long ending with claws and a seta. *Genitalia* (Fig. 4, I): Parameres 0.10 mm long and 0.027 mm broad, broader at distal end and tapering at apical end forming an apical spine. Each paramere consisting of 6 setae in the middle, 4 on the inner margin and 5 on the outer margin. Aedeagus 0.09 mm long and 0.007 mm wide, bluntly tapering at apical end.

FEMALE: Body length from vertex to tip of ovipositor 1.350 mm. *Antenna:* Seven segmented: I 0.025 mm, II 0.062 mm, III 0.125 mm, IV 0.022 mm, V 0.035 mm, VI 0.027 mm and VII 0.046 mm. Sensorial cone and primary sensorium present as in male; *Wings*: Forewing 0.79 mm long and 0.23 mm wide; hindwing 0.67 mm long and 0.20 mm wide; *Legs:* Mesotibia 0.25 mm long, proximal tarsus and distal tarsus 0.07 mm long. Metatibia 0.30 mm long, proximal tarsus 0.1 mm and distal tarsus 0.08 mm. Mesotibial brush, metatibial cone and brush as in male.

Discussion

The study has shown the presence of 4 species of *Lipaleyrodes* in India out of 5 species known so far in this genus, and one has been found to be new to science.

In all the species there are uniformly 11 pairs of clusters of wax plates in the submargin excepting in *L. phyllanthi* which has been reported to have 10 to 12 pairs. However, considerable difference has been noticed in the number, size and pattern of wax plates in a cluster in each species. The wax plates are polygonal in *L. euphorbiae,* oval in *L. breyniae* and *L. crossandrae,* hexagonal in *L. phyllanthi* and characteristic irregular petal-like in *L. vernoniae.* The dorsal setae are extremely long in *L. crossandrae,* whereas first abdominal setae are wanting in *L. breyniae* and *L. phyllanthi.* In *L. vernoniae* the dorsal setae are more or less of uniform size, whereas in *L. euphorbiae* the first abdominal setae varied in size from minute to long. *L. euphorbiae* differed distinctly from all other known species in possessing 8 pairs of minute setae in sub-dorsal area, 4 on cephalic region and 4 towards posterior part of abdomen.

L. euphorbiae occurs on euphorbiaceous plants whereas *L. vernoniae* is known from Compositae. *L. crossandrae* infests plants belonging to Amaranthaceae and Acanthaceae, whereas *L. breyniae* is restricted to plants belonging to Euphorbiaceae and Papilionaceae. It is interesting to note that *L. phyllanthi* occurs on *Phyllanthus* sp. in Madagascar and is similar to *L. breyniae* in not possessing the first abdominal setae but differs from it in having hexagonal wax plates.

The study of adult characteristics has shown that the compound eyes are joined by single ommatidium in all the species examined. No significant variation has been noticed in the antennal structures of both male and female. Eggs and wings also did not exhibit any difference. Variations could be noticed mainly in the mesotibia and metatibia and in the male genitalia which are presented in Table 1.

Gill (1990) has highlighted the joining of upper and lower section of compound eyes by ommatidium. According to Esther (1991) in *Aleurolobus orientalis* (Aleurolobini), *Trialeurodes ricini* and *T. vaporariorum* (Trialeurodini) the compound eyes are distinctly separated and not connected by ommatidium. On the other hand she observed species studied under Dialeurodini and Aleyrodini have compound eyes joined by two ommatidia, whereas in *Bemisia tabaci* (Bemisini) they are joined by single ommatidium. Interestingly in the species of *Lipaleyrodes* (Lipaleyrodini) they are joined by

Table 1

Species	Mesotibia		Metatibia			No. of setae in paramere		
	No. of brush	No. of setae in each brush	No. of brush	No. of setae	No. of setae in the comb	Inner margin	Outer margin	Mid region
L. euphorbiae	2	2/2	1	2	14	4	5	7
L. crossandrae	2	2/2	1	2	12	4	7	8
L. vernoniae	2	2/3	1	3	11	4	5	6
L. breyniae	*	*	*	*	*	4	7	7

* Not observed: From figure of Singh (1931).

single ommatidium. It may be of interest to note that the pupal case of Bemisini and Lipaleyrodini look alike except for the demarcation of submargin with clusters of wax plates. Joining of compound eyes by single ommatidium is probably characteristic of the tribes Bemisini and Lipaleyrodini which needs to be confirmed by the study of considerable number of species from the tribes.

The variations in the number of setae in meso- and metatibial brush and in the metatibial comb in addition to the variations in the setae present on inner and outer margins and mid region of parameres are of significance in aleyrodid taxonomy at species level.

Acknowledgements

Thanks are due to CSIR for Research Associateship to Dr. (Miss) K. Thenmozhi under which this work was carried out. Thanks are due to Dr. P. Balakrishnamurthy, Director and Dr. C. Peter, Head, Entomology Dept., Fredrick Institute of Plant Protection and Toxicology, Padappai for facilities provided.

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A CATALOGUE OF THE BIRDS IN THE COLLECTION OF BOMBAY NATURAL HISTORY SOCIETY-36: MOTACILLIDAE

Saraswathy Unnithan

[*Continued from Vol. 89 (1)*: 71]

This part covers 1022 specimens of 41 species and subspecies, Nos. 1852 -1891 in the Indian handbook and synopsis and 6 extra limitals. Of the 41 from Indian limits we have no specimens of 6 forms (1 species and 5 subspecies).

1852. **Anthus hodgsoni hodgsoni** Richmond (Calcutta) Indian Tree Pipit 3:281, 282

52: 26 males 13 females 13 o?

1 Chitral, 1 Dakuri, 2 Dharmsala, N.W.H.; 2 Badrinath, Garhwal; 1 Bharatpur, Rajasthan; 2 Mahabaleswar, Maharashtra; 1 Barkot, Bamra, Orissa; 1 Baghowni, Darbhanga; 1 Rangpo, 1 Rinchinpong, W. Sikkim, 3 Chungthang, Lachung, N. Sikkim; 4 Gedu, 2 Sanchi, 1 Honku, W. Bhutan, 5 Bumthang, 2 Mangdechu, 2 Gyetsa, 1 Shamgong, 1 Batase, 1 Tama, C. Bhutan, 3 Gomchu, 1 Rongtong, 4 Narphong, 3 Wamrong, 1 Deothang, C. Bhutan; 1 Tirap; 1 *Nyenyam, S. Tibet*; 1 *Kamaing, Burma*, 1 *Hai Bum*, 1 *Prome, Burma.*

Measurements on p. 355.

1853. **Anthus hodgsoni yunnanensis** Uchida & Kuroda (Yunnan) Siberian Tree Pipit 3:283

47: 22 males 19 females 6 o?

1 Simla; 1 Mahal, Surat Dangs, S. Gujarat; 1 Bhanupratappur, Kanker, C.P., 1 Kameli, Bailadila Dt., Bastar, C.P.; 1 Molem, Goa; 1 Wynaad, S. India, 1 Padagiri, Nelliyampathy Hills, Cochin, 1 Mt. St. Mary, 1 Kodaikanal; 1 Lankapakhala, 1 Sileru, Vizag; 1 Mahendragiri, 1 Keonjhargarh env., 3 Badrama, Bamra, 1 Upper Barakamara, Simlipal, Orissa; 1 Banares; 1 Manjhaul, Monghyr Dt., Bihar; 2 Singtam, Teesta Valley, 3 Temi, W. Sikkim; 1 Goalpara, Assam, 1 Sadiya, Upper Assam; 1 Mishing, Abor Exp. 1 Miao, Arunachal Pradesh; 10 *Temple of Heaven, Peking*, 1 *Singhaling*, 1 *Pantha, E. Bank*, 1 *Tagahka*, 1 *Shurdaung, Prome Dt.*, 1 *Tanyagyi, Sandoway Dt.*, 1 *Sandoway Dt.*, 1 *Pumsin* 1 *Henzada Dt., Burma*; 1 no locality.

Measurements on p. 355.

1854. **Anthus trivialis trivialis** (Linnaeus) (Sweden) European Tree Pipit 3:279

49: 19 males 17 females 13 o?

5 *Hawiplain*, 3 *Nahr Umar, L. Bank of River Tigris*, 1 *Feluja, R. Euphrates, Mesopotamia.* 1 *Randha, Tauhat*, 1 *Basra*, 1 *Tunb Island*, P. *Gulf*, 1 *Dusdab, S.E. Sistan, Persia*; 1 Keonthal St., 1 Koti St., 1 Simla, N.W.H.; 1 Daryapur, 2 Amabala, Punjab; 1 Ranikhet, 1 Delhi, 1 Ganges Canal, Meerut; 2 Dhari, Amreli Dt., Kathiawar, 1 Songadh, Navsari Dt., Gujarat, 1 Cambay City Env., 1 Chikhli, 1 Sarwar, 2 Malegaon, 1 Pandwa, Surat Dangs, 1 Bagh, 2 Surwaya, Gwalior St., 1 Mathar, Narmada Valley, Bhopal St., 2 Karera Dt., Shivpuri, M.P., 1 Geedam, Bastar Dt.; 1 Chikalda, Berar, 1 Ghoti, 1 Nasik, 1 Raita, Kalyan, 1 Bhiwandi, 1 Thana Dt., 1 Pali Hill, 1 Santacruz, Bombay, 1 Mehda, Satara, 1 Rajapur, Ratnagiri; 1 Molem, Goa.

Measurements on p. 355.

1855. **Anthus trivialis haringtoni** Witherby (Gittidas, Kaghan Valley) Witherby's Tree Pipit 3: 280

37: 8 males 23 females 6 o?

5 Chitral, 2 Nawashahar, 1 Shikohpur, Jullunder; 1 Simla; 2 Keonthal State, 1 Koti State, N.W.H.; 2 Ambala, Punjab; 1 Almora, 3 Delhi; 2 Bharatpur; 1 Bhind, Gwalior State; 2 Bhivandi, 1 Wada, 1 Thana, 1 Vehar Lake, Salsette, 1 Kihim, Kolaba, 1 Walwan, Lona, Poona, 1 Satara; 1 Dhakna, 1 Beesaam, Kolkaz, 2 Raipur; Melghat, Berar, 1 Deglur, Nader Dt., 1 Palemani, N. Kanara; 2 Sankrametta, Vizag.

Measurements on p. 355.

1856. **Anthus pratensis** (Linnaeus) (Sweden) Meadow Pipit 8:661

nil.

1857. **Anthus novaeseelandiae richardi** Vieillot (France) Richard's Pipit 3:288

11: 4 males 6 females 1 o?

1 Bakri, Monghyr Dt., Bihar; 1 Bharatpur; 1 Chanderi, Gwalior st. C.I.; 1 Chembur Katchrapati, 1 Bhiwandi, 1 Salsette, 1 Nr. Thana; 1 Karwar, 1 N. Kanara; 1 Trivandrum env., Vellayani Lake; *1 Prome, Burma.*

Measurements on p. 355.

1858. **Anthus novaeseelandiae waitei** Whistler (Jhelum, Punjab) Northwestern Paddyfield Pipit 3: 290

31: 17 males 12 females 2 o?

1 Lahore, 1 Keonthal St., 1 Darazpur, 1 Ambala, Punjab; 1 Almora, 1 Delhi; 2 Bharatpur, 1 Bhimal, Jodhpur, Rajputana; 1 Rapar, 1 Ratnal, 1 Bhuj, 1 Godsar, Bhuj env., 2 Mandvi, Kutch, 1 Pariaj, Kaira Dt. 1 Mithapur, Okhamandal, Kathiawar, 1 Bodeli, Baroda Dt., 1 Golana, Cambay St., 1 Chinchli, Surat Dangs; 1

Sonawani, Balaghat Dt., 1 Saugar, C.P., 1 Jaithari, Bhopal, 1 Choli Tank, nr. Mandeleshwar, Indore, 1 Ratlam, C.I., 1 Chanderi, Gwalior; 5 Kanpur.

Measurements on p. 355.

1859. **Anthus novaeseelandiae rufulus** Vieillot (Bengal) Indian Paddyfield Pipit 3:290

57: 21 males 30 females 6 o?

1 Ghana Sanctuary, Bharatpur, 1 Bombay City, 2 The Esplanade, 1 Thana, 2 Pali Hill, Bandra, 1 Andheri, Salsette, 3 Santacruz, 1 Trombay, 1 Panchagini, 1 Chikalda, Berar, 1 South Konkan; 1 Santgal, N.Kanara, 1 Hikkeri, Sagar, 1 Shenemenalla, 3 Edbuthi, 1 Billaj, Billigirirangan Hills, 1 Mysore; 1 Mercara, Coorg, 3 Shevaroy Hills, S.I., 1 Madras; 1 Jeypore agency, 1 R.V. Nagar, Vizag; 1 Mavalam, Sriharikotta, 5 Godavari Delta, 1 Bausuri, 1 Anantapur, Keonjhar, 2 Balasore, 1 Simlipal Hills, Orissa; 1 Maniktala, Calcutta; 1 Cachar, 2 Shillong, Assam; 1 Samchi, W. Bhutan; 1 *South Shan States*, 1 *Prome*, 1 *Thayatmyo Dt.*, 1 *Sandoway Dt.;* 1 *Ataran*, 1 *Myoguin*, 3 *Henzada Dt.;* 2 no locality.

Measurements on p. 355.

1860. **Anthus novaeseelandiae malayensis** Eyton (Malaya) Malay Paddyfield Pipit 3:290,292

17: 12 males 5 females ,

1 Wadakkancheri, 2 Perumalmalai, Palani Hills, 1 Thattakkadu, 1 Santanpara, Cardamom Hills, 3 Peerumadu, 1 Kumili High Range, 1 Kumili, Periyar Lake, 1 Thekkady, 2 Golf Links, Trivandrum, 2 Muthukuzhy, Ashambu Hills, Travancore, 1 Cape Comerin; 1 Ceylon.

Measurements on p. 355-356.

1861. **Anthus campestris campestris** (Linnaeus) (Sweden) Tawny Pipit 3:292,293

85: 50 males 26 females 9 o?

1 *Helonan, Egypt*, 1 *Rt Bank of R. Tigris*, 1 *Feluja, Mesopotamia*, 1 *Sheiksaad*, 1 *Lejait, Euphrates*, 3 *Siyahad*, 1 *Halul Island, Persian Gulf*; 2 Campbellpur, Punjab, 1 Koti State, 1 Tara Devi, Keonthal State, 2 Shali Peak, Bhajji State, 4 Ambala, 2 Bhung, Bahawalpur State, 1 Lal Sohara, 2 Harunabad, 1 Bahawalpur tn. env., 1 Dadu, Larkana, Sind, 2 Khahi, Thar & Parkar Dt., Sind, 1 Bela Island, 1 Rapar, 2 Bhujia Fort, 1 Bhachau, 4 Manjal, Nakhatrama Dt., 1 Khavda, Pachham Island, 6 Kharirohar, 1 Kutch, 1 Radhanpore, N. Guj., 1 Deesa, Palanpore St., 1 Patan, Mehsana Dt., 1 Nadiad tn. env., 1 Bodeli, Baroda Dt., 1 Dohad, 4 Dwarka, Okhamandal, 2 Amreli, Kathiawar, 1 Kharaghoda, Gujarat; 1 Satanswara, 1 Bhind, 1 Badarwas, 1 Surwaya, Gwalior St., 1 Sanchi, Bhopal St. C.I., 1 Jabalpore, 2 Meerut, 2 Kanpur; 1 Chikalda, Berar, 1 Bassein, Thana Dt., 3 Andheri, 1 Juhu, 1 Salsette, 1 Satara; 2 N. Kanara; 1 Bengasai, Foot of Mahendragiri, 2 Koira, Bonai, 2 Keonjhargarh, 1 Badrama, 1 Barkot, Bamra, Orissa.

36 specimens (23 males, 11 females and 2 unsexed) collected in the month October to March are with streaks on the breast. They average 2-3 mm less in their wing and tail measurements than the unstreaked specimens.

Measurements on p. 356.

1862. **Anthus campestris kastschenkoi** Johansen (Novosibrisk, West Siberia) Siberian Tawny Pipit 3:292

nil.

1863. **Anthus godlewskii** (Taczanowski) (Argun River, South Dauria) Blyth's Pipit 3:289

12: 7 males 4 females 1 o?

2 Kuno, 2 Bhind, Gwalior St., 2 Jabalpore C.I.; 1 Karera, Shivpuri Dt., M.P.; 2 N. Kanara; 1 Aramboli, S. Travancore; 1 *S.E. Everest*, 1 *Kharta, S. Tibet.*

The hind claw is longer than the hind toe and according to the key in the HANDBOOK the birds are of this species.

Measurements on p. 356.

1864. **Anthus cervinus** (Pallas) (Siberia) Redthroated Pipit 3:294

15: 8 males 5 females 2 o?

1 *River Tanhat*, 1 *Aluzabal*, 2 *Feluja, R Euphrates*, 1 *Sheikh Saad, Mesopotamia*, 1 *Fahama, Bagdad*; 1 *Kyithe*, 1 *Tarokmaw*, 2 *Shurdaung*, 1 *Prome*, 1 *Yebank Henzada Dt., Burma;* 1 Kufri, Koti St., 1 Dabka, Baroda Dt.; 1 Narcondam.

Young birds have no red on the head, breast or throat. These parts are pale yellowish buff, immaculate on the centre of chin, throat and foreneck, heavily streaked with black on the sides and across the whole breast.

Measurements on p. 356.

1865. **Anthus roseatus** Blyth (Nepal) Vinaceousbreasted Pipit 3:295

34: 22 males 7 females 5 o?

1 Dodripass, Kishatwar, 1 nr Ramdach Pass, 1 Hygam, 1 Kashmir, 1 Kohat, N.W.F.P.; 1 Murree, 2 Asmi River, Patiala St.; 1 Kufri, 1 Koti St., 1 Simla Hills; 2 Fagu, 2 Keonthal St., 5 Kedarnath, 2 Badrinath, 1 Gupta Kashi, Garhwal, 1 Bhim Tal, Kumaon; 3 Jagadri, Punjab; 2 Jajjah Abbasian, Bahawalpur St., 1 Satanwara, Gwalior St.; 1 Chungthang, 1 Lachen, N. Sikkim; 2 Tezu, Lohit Valley, U. Assam.

Measurements on p. 356.

1866. **Anthus similis decaptus** Meinertzhagen (Rud-I-Taman, East Persia) Persian Rock Pipit 3:287

23: 9 males 10 females 4 o?

1 *Amara, Persia*, 1 *Tang Srgind*, 1 *Mishun Persian Gulf*, 1 *N.E. Baluchistan*, 1 *Harboi, Baluchistan*, 1 *Bampur, Persian Baluchistan*, 1 *Gusht, 42 M N W of Dizak, P. Baluchistan.;* 1

Karachi, 1 Campbellpur, W. Punjab; 1 Madhopur, 1 Ambala, Punjab, 1 Keonthal St., 1 Manthar, Cholistan, 2 Bhung, Bahawalpur State, 1 Lal Sohara, Bahawalpur tn. env., 4 Delhi; 1 Bhuj Kutch; 1 Ambarnath, 1 Bawamalang, Kalyan.

Measurements on p. 356.

1867. **Anthus similis jerdoni** Finsch (Kotegurh, northwest Himalaya) Brown Rock Pipit 3:286

20: 12 males 6 females 2 o?

1 Chitral, 1 Taxila, Punjab; 1 Solon, 1 Jutogh, 1 Simla Hills; 3 Ambala, Pujnab; 1 Hamgara, Almora, 1 Hohba, Garhwal, 1 Delhi; 2 Mir, Pachham Island, 1 Mandvi, Kutch, 1 Ajwa, 1 Baroda City env.; 1 Kuno, 2 Satanwara, Gwalior St.; 1 *Pakkokku.*

Measurements on p. 356.

1868. **Anthus similis similis** Jerdon (Jalna) Rufous Rock Pipit 3:285

nil.

1869. **Anthus similis travancoriensis** Ripley (Road to Muthukuzhi, Ashambu Hills, Travancore-Cochin State) Kerala Rock Pipit 3: 285

2 males

1 Billigirirangan Hills, Mysore; 1 Muthukuzhi, Ashambu Hills, Travancore.

Both the specimens were identified as *similis* by Salim Ali before the description of *travancoriensis.*

Measurements on p. 356.

1870. **Anthus nilghiriensis** Sharpe (Nilgiri Hills) Nilgiri Pipit 3:283

11: 6 males 4 females 1 o?

1 Mukurti, 2 Avalanche, 1 Parson's Valley, 1 Western Catchment, Nilgiri, 1 Perumalmalai, Palani Hills, 3 Anamudi High Range; 1 Eravikulam, Kerala; 1 no locality.

Measurements on p. 356-357.

1871. **Anthus spinoletta coutellii** Audouin (Egypte) Central Asian Water Pipit 3:297,298

29: 12 males 13 females 4 o?

1 *Hawiplain, Samarra, Mesopotamia,* 1 *Pir-i-Bann,* 1 *Aliabad, Shiraz,* 1 *Sheik Saad,* 1 *Chaman,* 1 *Quetta, Baluchistan;* 3 Hygam, Kashmir, 1 Chitral, 2 Peshawar, 1 Chhoi, nr. Campbellpur, 2 Campbellpur, 1 Kohat, 1 Bhong, Indus Riverine, 1 Rawalpindi, 2 Fagu, Keonthal St., 1 Simla; 2 Bahawalpur tn. env., 1 Pithoro, Sind; 4 *Peking.*

Most of the specimens are marked by earlier workers as *blakistoni=coutellii.*

Measurements on p. 357.

1872. **Anthus spinoletta japonicus** Temminck & Schlegel (Japan) Japanese Water Pipit 3: 299

1 male from *Maymyo, Burma.*

Measurement on p. 357.

1873. **Anthus sylvanus** (Hodgson) (Nepal) Upland Pipit 3:299

19: 10 males 6 females 3 o?

1 Sha Peak, Bhajji St., 1 Koti St., 1 Fagu, 8 Simla, 1 Simla Hills, 1 Keonthal St., N.W.H.: 1 Mussorrie, 1 Pologrounds, Mussorrie, 1 Gupta Kashi, 2 Pipal Kotki, Chamoli, Garhwal; 1 no locality.

Measurements on p. 357.

1874. **Motacilla indica** Gmelin (India) Forest Wagtail 3:276

18: 8 males 6 females 4 o?

1 Waghai, Surat Dangs; 1 Molem, Goa; 1 Jog Falls, 1 Kadra, 3 Karwar, 2 N.Kanara; 1 Kumili, Periyar Lake; 1 Mongwa, Darbhanga, Bihar; 1 Thugapur, Mayabunder, N. Andaman, 1 Interview Islands, Andaman, 1 Narcondam; 1 *Kyaugin Pier, Henzada Dt.,* 1 *Pegu, Yoma, Lower Burma,* 2 *Peking, China.*

In key to the species in INDIAN HANDBOOK this is included among those with "some yellow in the plumage", but no yellow is visible in any specimens, the last ones being dated 13th and 17th February, 1980.

Measurements on p. 357.

1875. **Motacilla flava thunbergi** Billberg (Lapland) Greyheaded Yellow Wagtail 3:269

42: 22 males 16 females 4 o?

1 *Lule Lapp,* 1 *Finmarken, Copenhagan Museum,* 2 no locality, *Copenhagen Museum,* 1 *Norway,* 1 *W. Kazakhstan,* 1 *Fahama, Bagdad,* 1 *Feluja, R. Euphrates, Mesopotamia;* 2 Jagadhri, 1 Ambala, Punjab; 1 Delhi, 1 Hamavas Lake, Pali Dt., 3 Bharatpur; 1 Devisar Tank, Bhuj environs, Pali Dt., 1 Wanoti, Bhuj, Kutch, 1 Vaghjipur, Mehsana Dt., Gujarat; 1 Choli tank, Mandaleswar, Indore state; 1 Pachora, E. Khandesh, 1 Juhu, Salsette, 1 Ratnagiri; 3 Thiruvalla, 4 Edanad, Kerala; 1 Barkul, Chilka Lake, Orissa; 1 Calcutta; 1 Baghownie, Tirhut, 1 Manjhaul, Monghyr Dt., Bihar; 1 Mayabunder, N. Andaman, 1 Choldhari, S. Andaman, 1 Narcondam, 1 Trinkut, Nicobar; 1 *Henzada Burma,* 3 *Peking, China.*

Measurements on p. 357.

1875 a. **Motacilla flava simillima** Hartert (Kamchatka) Short-tailed Greyheaded Yellow Wagtail 8:660

7: 3 males 4 females

2 *U.S.S.R.,* 1 *Jadon Chaung, Thayetmyo Dt.,* 2 *Henzada Dt., Burma;* 2 Edanad, Kerala.

Measurements on p. 357-358.

1876. **Motacilla flava beema** (Sykes) (Dukhun) Blueheaded Yellow Wagtail 3:267

43: 15 males 20 females 8 o?

2 *W. Kazakhstan*, 2 *C. Kazakhstan*, 1 *Tanb Island, P. Gulf*, 4 *Mamian, C. Afghanistan*, 1 *Faizabad, Seistan, Afghanistan;* 1 Chitral, 1 Upper Shaksgam, Kashmir, 2 Jagadhri, Ambala, Punjab; 1 Hamavas Lake, Pali Dt., 1 Bharatpur, Rajasthan; 2 Juhu, 1 Andheri, Salsette, 1 Pali Hill, Bandra; 1 Godavari Delta, 1 Cumbum Valley, Kurnool Dt.; 8 Edanad, Chengannur, 2 Thiruvalla, Kerala; 1 Baud, Orissa; 2 Calcutta; 3 Baghownie, Tirhut; 1 Dibrugarh, Assam; 1 Camorta, 1 Trinkut, Nicobar; 1 *Henzada Dt., Burma;* 1 no locality.

Measurements on p. 357-358.

1877. **Motacilla flava lutea** (Gmelin) (Astrakhan) Yellowbacked Wagtail

nil.

1878. **Motacilla flava melanogrisea** (Homeyer) (India)

Turkestan Blackheaded Wagtail 3:272

38: 21 males 11 females 6 o?

1 *Central Kazakhstan*, 1 *Near Alma-Ata, Kazakhstan*, 1 *Ala Kaul Lake, East Kazakhstan*, 1 *Feluja, R. Euphrates, Mesopotamia*, 2 *Katunak, 8 m SW. of Shiraz*, 2 *Shaikh Saad*, 1 *Enjeli*, 1 *Kain, Persia*, 1 *Tamb Island, P. Gulf;* 3 Panjgur, Kalat, 1 near Jidi, Khojdar, Baluchistan, 3 Manthar, Cholistan, Bahawalpur, 1 Pakpattan, 1 Ambala, 1 Daragpur, Punjab; 1 Pithoro, Sind; 1 Sha Hassan, Manchar Lake, Larkana Dt., 2 Delhi, 1 Kanpur; 1 Kutch, W.India, 1 Dholovira, Khadir Island, 1 Jakhan, Kutch; 1 Madhmeshwar, Nasik, 2 Pali Hill, Bandra, 2 Andheri, 1 Juhu, Salsette, 1 Goregaon, Bombay; 1 N. Kanara; 1 no locality.

Measurements on p. 357-358.

1879. **Motacilla flava leucocephala (Przevalski) (Altai)**

Whiteheaded Yellow Wagtail 3:270

nil.

1880. **Motacilla flave taivana** (Swinhoe) (Formosa)

Greenheaded Yellow Wagtail

nil.

EL. **Motacilla flava flava** Linnaeus (S.Sweden)

The Blue-headed wagtail

5: 2 males 2 females 1 o?

4 from *Western Kazakhstan* and 1 no locality, *Berlin Museum*.

Measurements on p. 357-358.

EL. **Motacilla flava campestris** Pall (E. Russia)

2 females from *Shaik Saad, Tigris*.

Measurements on p. 358.

EL. **Motacilla flava dombrowskii** (Tschusi) (Roumania)

11: 6 males 2 females 3 o?

5 *Feluja, R. Euphrates, Mesopotamia*, 4 *Shaik Saad*, 1 *Busra*, 1 *Qabr.un-nokada Island, Khor Musa*.

Vaurie (1959) in 'The Birds of the Palearctic fauna' considers this subspecies as a hybrid.

Measurements on p. 357-358.

1881. **Motacilla citreola citreola** Pallas (Siberia)

Northern Yellowheaded Wagtail 3:273

28: 14 males 9 females 5 o?

2 Chitral, 1 Wana, Waziristan, NWFP; 2 Panjgur, Kalat, Baluchistan, 1 Gwambuk Kaul 50 m south of Panjgur, 1 Dadu, Larkana, Sind; 1 Daragpur, Ambala; 3 Jagadhri, 1 Pakpattan, Punjab; 1 Keonthal state, 1 Koti State, NWH.; 1 Baghowni, Tirhut; 1 Bumthang, C. Bhutan; 1 Bharatpur; 1 Jabalpur, C. India; 1 Kharaghoda, Gujarat; 1 Pali Hill, Bandra, 1 Mud Flats, Sion-Causeway, 1 Goregaon, 1 Tulsi lake, Salsette, 2 Bhaynder Mud Flats, Bombay; *1 Letpanta, Prome Dt., 1 Thayettaw, Henzada Dt., Burma, 1 Peking, China.*

Measurements on p. 358.

1882. **Motacilla citreola werae** (Buturlin)

(Sura valley, Simbirsk, Southeastern Russia)

Western Yellowheaded Wagtail 3:273

30: 14 males 8 females 8 o?

1 *Kelmen Ridge, Tian-shan, USSR*, 1 *near Alma-Ata, Kazakhistan, USSR;* 2 Chitral, 1 Wana, Waziristan, NWFP.; 1 Borgi Pass, Baltistan, 1 Sonamarg, Kashmir; 1 Mulbek, Ladak, 1 Bumni, Ladwa Dt., 1 Ladwa, 1 Jagadhri, 1 Ambala, 1 Rohtak, Punjab; 1 Ruthiai, Gwalior St., C.I.; 1 Godsar, Bhuj environs, Kutch, 1 Ajwa, Baroda Dt.; 1 Andheri, Salsette, 2 Kalyan, 1 Panvel, Kolaba Dt., 1 Edanad, Kerala; 2 Kanpur; 2 Bakhri, 1 Manjhaul, Monghyr Dt., Bihar; 1 *Peking*, 1 *Sughuluk, Kashgar*, 1 *Kashgar, China;* 1 no locality.

Measurements on p. 358.

1883. **Motacilla citreola calcarata** Hodgson (Nepal)

Blackbacked Yellowheaded Wagtail 3:274

18: 13 males 2 females 3 o?

1 *Tian-shan, USSR*, 1 *Kain, Persia;* 1 Gilgit, 1 Yusmarg, 1 Hygam, 1 Panamik, 1 Borgipass, Baltistan, 2 Upper Ind Valley, Kashmir, 2 near Suru, Ladak; 3 Jagadhri, Ambala; 1 Bahawalnagar, Bahawalnagar St., Punjab; 1 Simla Hills, NWH., 1 Bharatpur; 1 Phalut, Darjeeling.

Measurements on p. 358.

1884. **Motacilla caspica caspica** (Gmelin)

(Southern shore of Caspian Sea) Grey Wagtail

3:265

64: 37 males 18 females 9 o?

1 *Chu-Ilimountains, Kazakhstan*, 1 *Alma-Ata, USSR*, 1 no locality *(Russian Museum)*, 2 *Sheikh Saad*, 1 *Shaiba*, 1 *Hawiplain, Samarra, Mesopotamia*, 1 *Tangi-i-Sirha, 36 m NW. of Geh*, 1 *Geh, Persian Baluchistan;* 2 Chitral, 1 Gulabgarh, Kishtwar, 1 Murgo, Kashmir, 1 Tara Devi, 1 Ashni river, Patiala St.; 1 Gama-ki-Hatti, Dharmi St., 1 Jabli, Bhagat St., 1 Koti St., 11 Simla, NWH.; 2 Peora, Almora, 1 Darmar, Ranikhet, 1

Rambara, Kedarnath, 1 Malari, Niti, Garhwal; 1 Mamar village, Sind Valley; 1 Bhimsar Tank, Anjar Dt., Kutch, 1 Surwaya, Gwalior St., C.I; 1 Antagarh, Bastar Dt. 2 Barkul, Chilka lake, Orissa; 2 Borivli, Salsette, 1 Tulsi lake, 2 Pali Hill, 1 Bandra, 1 Nagotra, Kolaba Dt.; 1 Karwar; 1 Nallamalai Range, S. Kurnool; 2 Shembagnur, 1 Santan Para, Cardamom Hills; 1 Travancore High Range, 1 Maraiyur, Munnar, 1 Travancore, 1 Edanad, Chengannur, Kerala; 4 Narcondam, 1 S. Andaman, 1 Car Nicobar; 1 *Pakokku*, 1 *Khayankchaung, Thayetmyo Dt., Burma.*

Measurements on p. 358.

1885. **Motacilla alba dukhunensis** Sykes (Dukhun) 3: 257

37: 27 males 7 females 3 o?

1 *Sha saud*, 1 *Siyahad*, 1 *Sheih Saad*, 1 *Tehran-Kasvin Road, Persia*, 1 *Ranta river, Persian Baluchistan;* 3 Chitral, 1 Kishtwar, 1 Nishant Bagh, Dal lake, Kashmir, 1 Bahawalpur, 1 Gama-ki-hatti, Dharmi St.; 1 Garhwal, 2 Delhi, 1 Kanpur; 1 Guna, Gwalior St., 1 Jabalpur; 1 Anantapur, Orissa; 1 Bhopalpatnam, Bastar Dt.; 1 Bhuj, 1 Kutch, 1 Bodeli, Baroda Dt.; 1 Kalyan, Thane, 1 Juhu, 2 Pali Hill, Bandra, 3 Santacruz, 1 Kurla, 1 Backbay, Colaba, Bombay, 1 Nagotra, Kolaba, 1 Mehda, Satara, 1 Harnai, 1 Ratnagiri; 1 Cumbum Valley, Kurnool Dt.

Measurements on p. 358-359.

1886. **Motacilla alba personata** Gould (Bengal) Masked Wagtail 3:259

38: 15 males 17 females 6 o?

1 *Shiraz, Persia*, 2 *Gusht, Persian Baluchistan;* 3 Wana, Waziristan; 1 Kilia, Drosh, 8 Chitral, 1 Gilgit, 1 Kashmir; 1 Bahawalpur tn. env., 2 Ambala, Punjab, 1 Kandaghat, Patiala St.; 3 Simla, NWH.; 1 Garhwal, 1 Ramgarh, Naini Tal, 2 Kanpur; 3 Bharatpur; 1 Koyna, Maharashtra; 1 Kodambakkam, Chingelpet Dt., Madras; 1 Nahar, Madhubani, 1 Baghownie, Darbhanga Dt., Bihar; 1 Sadiya, Upper Assam; 1 Bumthang, C. Bhutan; 1 *Kashgar, China.*

Measurements on p. 358-359.

1887. **Motacilla alba alboides** Hodgson (Nepal) Hodgson's Pied Wagtail 3:262

22: 18 males 2 females 2 o?

1 Chitral, 1 Kashmir Valley, 1 Taukse, Ladak, 1 Jagadri, 1 Mubarikpur, 4 Chandigarh, Ambala Dt., 4 Baurpa, Niti Pass, Garhwal; 1 Tezu, Lohit Valley, 1 Sadiya, U.Assam; 1 Gedu, West Bhutan, 1 Bumthang, Central, 1 Narphong, East, 3 Rongtong, East Bhutan; 1 Miao, Tirap Division, Arunachal Pradesh.

Measurements on p. 358-359.

1888. **Motacilla alba leucopsis** Gould (India) Whitefaced Pied Wagtail 3:264

7: 3 males 4 females

1 Somatipur, Bihar; 1 *Gamon Chaung, Sandoway* Dt., 1 *Tarobman, Prome*, 1 *Toungoo*, 1 *Legongyi, Henzada Dt.*, 1 *Thanichaung forest, Thayetmyo*, 1 *Burma.*

Measurements on p. 358-359.

1889. **Motacilla alba ocularis** Swinhoe (Amoy, China) Streakeyed Pied Wagtail 3:261

2 males from *Peking, China.*

Measurements on p. 359.

1890. **Motacilla alba baicalensis** Swinhoe (Eastern Asia-Lake Baikal) Swinhoe's Pied Wagtail 3:260

25: 14 males 10 females 1 o?

1 *Sheik Saad*, 1 *Sistan Delta*, 1 *Pul-i-Fasa, 12 m E. of Shiraz, Persia;* 2 Wana, Waziristan; 3 Chitral, 1 Hygam, Kashmir; 1 Shikohpur, Jullunder, 1 Ambala; 1 Chachran, Bahawalpur St., 1 Fagu, Keonthal St., 1 Dadu, Larkana, Sind.; 1 Delhi, 2 Meerut, 1 Kanpur; 1 Bharatpur; 1 Kutch; 1 Ratlam, C.I.; 2 Baghownie, Tirhut, 1 Madhubani, Bihar; 1 Narphong, E. Bhutan.

Measurements on p. 359.

EL. **Motacilla alba alba** Linnaeus

5: 3 males 2 o?

1 *Sheik Saad*, 2 *Aliabad (Karabagh) 13m SE. of Shiraz, Persia*, 1 *Geh*, 1 *Magas, P. Baluchistan.*

Measurements on p. 359.

EL. **Motacilla alba persica** Blanf (Niris east of Shiraz)

1 Unsexed from *Shustar, S. Persia.*

EL. **Motacilla alba lugens** Gloger (Kamchatka)

1 male from *Suminoe, Osaka, Japan.*

Measurement on p. 359.

1891. **Motacilla maderaspatensis** Gmelin (India = Madras) Large Pied Wagtail 3:263

26: 17 males 9 females

1 Jagadri, 2 Chandigarh, Ambala, 1 E. Dehradun, 1 Bageswar, Almora; 1 Kuno, Gwalior, 1 Mt. Abu; 1 Godsar, Bhuj env., Kutch; 2 Koyna River Valley, Maharashtra, 2 Ratnagiri; 1 Karwar, 1 Kadra, Kanara, 1 Ulavi, Sagar, Mysore; 1 Freserpet, Kushalnagar, N. Coorg, 2 Santhanpara, Cardamom Hills; 2 Travancore, 1 Kanyakumari Dt., 1 Kalai, Trichinapoly, 1 Gingee, S. Arkot; 1 Koduru, S. Cuddapah; 2 Barkul, Chilka lake, 1 Ramgarh, Band, Orissa.

Measurements on p. 359.

Acknowledgements

From 1992-94, British Museum (Natural History) gave us 3 loans of 16 species and subspecies of *Anthus* specimens from their collection to compare with our specimens. The help is gratefully acknowledged.

Part 36

	Wing	Bill	Tarsus	Tail
		1852-53. *Anthus hodgsoni* subspp.		
Male				
hodgsoni (26)	75-91 av. 83.1	11-12 av. 11.4	20-23.5 av. 20.9	56-60 av. 58.6
	(IH 79-90	from skull 13-16	20-22	53-68)
yunnanensis (22)	78-87 av. 83.5	10-11 av. 10.6	19.5-22 av. 20.8	54-65 av. 60.2
	(IH 81-90	from skull 13-15	20-22	51-66)
Female				
hodgsoni (13)	79-85 av. 81.2	10.4-14 av. 11.1	20-22.5 av. 21.2	56-63 av. 58.7
	(IH 77-85	from skull 14-16	20-22	50-67)
yunnanensis (19)	78-87 av. 83.9	10-11.7 av. 10.8	19.5-22 av. 20.8	54-65 av. 60.2
	(IH 77-86	from skull 13-15	20-22	52-62)
		1854-55. *Anthus trivialis* subspp.		
Male				
trivialis (19)	84-90 av. 86.4	10-11.9 av. 11.03	20-22 av. 20.9	58-67 av. 61.6
	(IH 82-95	from skull 13-15	20-22	50-68)
haringtoni (8)	81-88 av. 85.8	10.6-12 av. 11.3	20-22 av. 20.9	56-64 av. 60.1
	(83-94	from skull 14-16	20-22	54-63)
Female				
trivialis (17)	81-90 av. 86.06	10-12 av. 10.9	20-22 av. 20.9	57-64 av. 60.7
	(IH 80-90	from skull 13-15	19-21	51-65)
haringtoni (23)	81-89 av. 83.6	10-11.5 av. 10.9	19-22.5 av. 20.7	55-62 av. 58.7
	(IH 83-91	from skull 14-16	20-22	54-64)
		1857-60. *Anthus novaeseelandiae* subspp.		
Male				
richardi (4)	93-99 av. 95.7	14-15 av. 14.4	30-32.5 av. 30.6	72-75 av. 73.7
	(IH 89-102	from skull 16-21	28-33	63-78)
waitei (17)	78-84 av. 81	11.5-13.5 av. 12.5	24.5-28 av. 26.3	54-65 av. 57.7
	(IH 76-86	from skull 15-17	24-27	49-56)
rufulus (21)	75-83 av. 79.5	12-13.5 av. 12.7	23.8-27.5 av. 25.8	53-60 av. 56
	(IH 77-87	from skull 16-18	24-28	50-60)
malayensis (12)	77-84 av. 80.8	12.5-14.1 av. 13.2	24.5-27.5 av. 26	52-59 av. 56.2
	(IH 77-87	from skull 16-18	24-28	51-62)
Female				
richardi (6)	93-99 av. 95.7	14-15 av. 14.4	30-32.5 av. 30.6	72-75 av. 73.7
	(IH 86-97	from skull 15-19	28-33	62-72)
waitei (12)	78-84 av. 81	11.5-13.5 av. 12.5	24.5-28 av. 26.3	54-69 av. 57.7
	(IH 75-82	from skull 15-17	24-27	49-56)
rufulus (30)	74-84 av. 78.1	12-14 av. 12.9	24.5-26.7 av. 25.4	51-58 av. 54
	(IH 74-84	from skull 16-18	24-28	50-60)

	Wing	Bill	Tarsus	Tail
malayensis (5)	74-81 av. 77.2	13.1-13.6 av. 13.3	23.5-26 av. 25.1	50-57 av. 53.8
	(IH 74-84	from skull 16-18	24-28	50-60)
1861. *Anthus compestris* subsp.				
Male				
compestris (50)	81-94 av. 88.5	13-15 av. 13.8	24.5-27.6 av. 25.8	62-75 av. 66.9
	(IH 88-101	from skull 18-20	25-28	61-76)
Female				
compestris (26)	77-89 av. 85	13-15 av. 14	24.5-27.5 av. 25.6	54-71 av. 64.1
	(IH 82-91	from skull 17-20	24-26	59-60)
1863. *Anthus godlewskii*				
Male (7)	89-94 av. 91.1	12.6-14.5 av. 13.7	24-27.5 av. 26.1	60-70 av. 64.8
	(IH 90-97	from skull 16-18	25-28	62-70)
Female (4)	88-92 av. 89.5	12.8-14 av. 13.8	25.5-27.5 av. 26.3	63-70 av. 66.7
	(IH 84-93	from skull 16-18	24-27	59-69)
1864. *Anthus cervinus*				
Male (8)	79-89 av. 84.2	11.3-12.7 av. 12	20.5-23 av. 22	55-61 av. 58.6
	(IH 83-90	from skull 14-15	21-22	49-56)
Female (5)	80-87 av. 81.1	11.1-12.5 av. 11.7	21-24 av. 22.2	50-59 av. 54
	(IH 79-87	from skull 14-15	21-22	47-55)
1865. *Anthus roseatus*				
Male (22)	81-96 av. 87.2	11-13 .5 av. 12.5	21-25.2 av. 23	58-70 av. 65.2
	(IH 84-96	from skull 15-17	22-24	57-69)
Female (7)	80-84 av. 82	11-13 av. 11.8	22-23 av. 22.4	55-60 av. 58.2
	(IH 79-87	from skull 15-16	22-24	52-64)
1866-69. *Anthus similis* subspp.				
Male				
decaptus (9)	89-103 av. 98.66	14-17 av. 15.2	26-30 av. 28	70-90 av. 82.1
	(IH 94-105	from skull *c.* 20	--	80-91)
jerdoni (12)	94-104 av. 98.6	15.7-17.5 av. 16.1	27.5-29.5 av. 28.7	75-87 av. 81.5
	(IH 97-105	from skull 19-21	28-30	80-91)
travancoriensis (2)	91, 98	16, 16.7	29, 29	75, 75
	(IH 90-96	from skull 19-21	26-28	72-79)
Male				
decaptus (10)	94-101 av. 97.2	15.5-17.5 av. 16.2	28.2-30 av. 28.9	80-86 av. 82.7
	(IH 95-101	from skull *c.* 20	--	80-87)
jerdoni (6)	93-98 av. 95.1	15-16.5 av. 16	27.2-30 av. 28.6	75-85 av. 80.5
	(IH 95-99	from skull 19-21	28-30	80-88)
1870. *Anthus nilghiriensis*				
Male (6)	74-80 av. 77	12.1-13.5 av. 12.8	25-27.1 av. 26.1	58-65 av. 62.3
	(IH 76-81	from skull 15-17	24-27	53-66)

	Wing	Bill	Tarsus	Tail
Female (4)	70-74 av. 72.2 (IH 73-82	12.4-12.7 av. 12.5 from skull 14-16	25-27 av. 25.7 24-27	56-60 av. 58.2 52-67)
1871-72. *Anthus spinoletta* subspp.				
Male				
coutellii (12)	85-96 av. 90 (IH 88-96	12.5-14.2 av. 13.3 from skull 16-18	22-24.5 av. 23.5 23-24	61-70 av. 65.6 59-66)
japonicus (1)	93 (IH 86-91	13.8 from skull 15-17	24.3 22-25	72 54-62)
Female				
coutellii (13)	80-92 av. 85.3 (IH 83-90	12.2-13.8 av. 12.9 From skull 16-18	22-25 av. 23.2 23-24	55-66 av. 61 56-61)
1873. *Anthus sylvanus*				
Male (10)	78-84 av. 80.3 (IH 78-84	12.5-14.5 av. 13.2 from skull 16-18	24-25.5 av. 24.7 24-25	60-75 av. 67.3 59-70)
Female (6)	72-81 av. 77.6 (IH 74-80	12.2-13.7 av. 12.9 from skull 16-18	23.5-25.2 av. 24.3 24-25	65-69 av. 66.7 56-69)
1874. *Motacilla indica*				
Male (8)	76-84 av. 80.5 (IH 79-83	12-14.1 av. 13.6 from skull 16-18	21.5-23 av. 22.2 23-24	67-73 av. 69.8 69-77)
Female (6)	77-81 av. 79 (IH 76-82	12-14.5 av. 13.3 from skull 16-17	21-22.8 av. 21.8 *c.* 22	66-68 av. 66.8 68-71)
1875-1880. *Motacilla flava* subspp. & ELs				
Male				
thunbergi (22)	76-86 av. 81.5 (IH 81-85	11.1-13.1 av. 12.2 from skull 15-16	22.5-26.6. av. 23.6 23-24	64-72 av. 69.3 71-77)
simillima (3)	75, 83, 84 (IH 78, 83	12.1, 12.7, 13.8 from skull 14, 16	23, 23.5, 24.5 24	62, 70, 71 69)
beema (15)	77-82 av. 80.4 (IH 78-84	11-13.2 av. 12 from skull 15-16	22-25 av. 23.5 22-25	65-72 av. 68.4 67-73)
melanogrisea (21)	76-88 av. 89.9 (IH male, female 75-85	11-13.5 av. 12.4 from skull 16-18	22.5-26 av. 24 23-24	65-76 av. 68.6 64-76)
EL-*flava* (2)	78, 85 (BHB 80-84	13, 13.1 from skull 13-15	23.5, 23.5 22-24	65, 74 69-76)
EL-*dombrowskii* (6)	77-83 av. 79.8	11.7-12.6 av. 12.1	21-24.3 av. 22.8	63-71 av. 67.6
Female				
thunbergi (16)	75-83 av. 79 (IH 70-80	11.5-13.5 av. 12.5 from skull 15-16	22-24 av. 23.3 22-25	63-72 av. 67.2 70-71)

	Wing	Bill	Tarsus	Tail
simillima (4)	75-79 av. 77.5	11.5-13.2 av. 12.2	23-24.5 av. 23.7	64-72 av. 67
	(IH 78, 78	from skull 14, 16	23	66, 67)
beema (20)	74-80 av. 77	11-12.5 av. 11.9	21.2-24.5 av. 23.2	62-69 av. 65.4
	(IH 77-88	from skull 15-16	22-23	67-71)
melanogrisea (11)	75-80 av. 77.5	11.5-14 av. 12.4	22-25 av. 23.2	62-71 av. 66.4
EL-*flava* (2)	72, 75	10.5, 12	22.5, 22.5	63, 65
	(BHB 76-82)			
EL-*compestris* (2)	82, 82	11, 11	24.5, 25	70, 72
EL-*dombrowskii* (2)	75, 77	12, 12	22, 23.5	65, 67
1881-83. *Motacilla citreola* subspp.				
Male				
citreola (14)	80-85 av. 82.8	12-14.5 av. 12.6	23-27 av. 25.1	67-78 av. 71.5
	(IH 81-86	from skull 15-17	23-27	71-84)
werae (14)	75-89 av. 82.6	11.5-13.7	22-27.5 av. 24.5	67-80 av. 71.9
	(IH 75-86	from skull 15-17	23-26	69-75)
calcarata (13)	80-87 av. 85	12-13.7 av. 13	24.5-28 av. 26.4	66-78 av. 72.6
	(IH 80-88	from skull 18-19	26-28	68-84)
Female				
citreola (9)	75-89 av. 81.2	11.5-14 av. 12.7	22-26 av. 24.2	65-79 av. 70
	(IH 83-84	from skull 15-17	23-27	79-80)
werae (8)	77-86 av. 80.1	12-13.5 av. 12.9	23-26.5 av. 25	67-74 av. 69.8
	(IH 72-79	from skull 15-17	23-26	—)
calcarata (2)	78, 83	13, 14	26.5, 26.5	60, 70
	(IH 77-81	from skull 18-19	26-28	66-80)
1884. *Motacilla caspica caspica*				
Male (37)	77-88 av. 83.1	11-14 av. 12.3	17.5-25 av. 21.2	64-69 av. 87.3
	(IH 81-87	from skull 15-17	18-22	88-98)
Female (18)	79-87 av. 81.2	10.5-13.7 av. 11.7	19-22.1 av. 20.4	80-93 av. 87.7
	(IH 78-84	from skull 15-17	18-22	80-97)
1885-90. *Motacilla alba* subspp. & ELs				
Male				
dukhunensis (27)	82-95 av. 88.5	11.5-14.5 av. 12.4	21.6-26.2 av.23.8	82-92 av. 85.6
	(IH 87-96	from skull 15-16	23-25	82-96)
personata (15)	87-98 av. 91.6	11.7-13.8 av. 13.1	22.5-25.5 av. 24.2	80-100 av. 87.4
	(IH 90-98	from skull 16-18	--	93-102)
alboides (18)	86-101 av. 92.8	12.5-15 av. 13.8	23-26 av. 24.5	83-97 av. 88.5
	(IH 90-105	from skull 18-19	23-25	87-97)
leucopsis (3)	88, 91, 95	13.5, 13.5, 14.5	23, 23.8, 26	78, 82, 88
	(IH 87-96	from skull 17-18	--	85-93)

	Wing	Bill	Tarsus	Tail
ocularis (2)	92, 93	11.5, 12.5	24, 24.5	82, 85
	(IH 92-101	from skull 16-18	--	93-99)
baicalensis (14)	83-94 av. 89.4	11-13.2 av. 12.2	22.5-26 av. 24.1	78-92 av. 85.2
	(IH 93-100	from skull 16-18	*c.* 24	88-98)
EL-*alba* (3)	87, 90, 97	12.1, 13, 14	23, 24.5, 25	86, 87, 89
	(BHB 87-96	from skull 13-15	23.5-26	85-93)
EL-*lugens*	96	13.5	23	91
Female				
dukhunensis (7)	84-91 av. 88.5	11.1-12.8 av. 11.8	22-24 av. 23.3	78-86 av. 83.3
	(IH 83-92	from skull 15-16	20-22	81-93)
personata (17)	85-97 av. 90.8	12-14.5 av. 13	23.5-26 av. 24.6	81-93 av. 88.2
	(IH 87-95	from skull 16-17	--	84-100)
alboides (2)	89, 90	13.2, 13.3	25, 25	85, 88
	(IH 87-95	from skull 18-19	--	84-94)
leucopsis (4)	85-95 av. 90	11.5-14.2 av. 12.8	24-24.5 av. 24.1	85-90 av. 86.5
	(IH 85-91	from skull 17-18	--	82-92)
baicalensis (10)	81-94 av. 86.5	11-12.6 av. 11.9	22.5-24.5 av. 23.4	81-90 av. 85.9
	(IH 86-96	from skull 16-18	*c.* 24	88-94)
		1891. *Motacilla maderaspatensis*		
Male (17)	94-101 av. 97.7	14.5-17.5 av. 15.5	25-28 av. 27.1	95-104 av. 98.8
	(IH 91-103	from skull 19-20	27-28	93-107)
Female (9)	90-99 av. 93.3	13.5--15.7 av. 14.8	25-28 av. 26.6	85-103 av. 94.6
	(IH 88-103	from skull 18-20	26-28	90-103)

(*to be continued*)

FRESH WATER FISH DIVERSITY IN ARALAM WILDLIFE SANCTUARY, KERALA, SOUTH INDIA[1]

C.P. Shaji, P.S. Easa and S. Chand Basha[2]

Key words: Aralam, freshwater, Kerala, Western Ghats

The rivers of Aralam Wildlife Sanctuary located in Kannur district, Kerala were surveyed in February 1995. Thirty three species of fishes were recorded. *Osteocheilus nashii* and *Noemacheilus nilgiriensis* were recorded for the first time from a west flowing river. Observation of *Puntius denisonii* indicates extension of range to the north of the Palghat gap in Western Ghats.

Introduction

The recent thrust on biodiversity conservation necessitates documentation of fauna and identification of biodiversity hot spots in Western Ghats. Day (1865, 1878) contributed to the fish fauna of India and Malabar. Pillay (1929), John (1936), Hora and Nair (1941) and Hora and Law (1941) reported the freshwater fishes of Kerala, especially the Travancore region. However, the freshwater systems north of Palghat gap were comparatively unexplored. Rajan (1955) described the freshwater fishes of Bhavani River System. Remadevi and Indra (1986) documented the fishes of Silent Valley National Park. Recently, Shaji and Easa reported extension of range of *Danio* (*Brachydanio*) *rerio* and *Noemacheilus petrubanarescui* to fresh waters of northern Kerala. Easa and Shaji also reported addition of *Puntius melanampyx* to the fish fauna of Silent Valley. The present survey was conducted to document the freshwater fishes of Aralam Wildlife Sanctuary.

Study Area

Aralam Wildlife Sanctuary forms a part of the contiguous chunk of forests comprising Reserve forests of Karnataka, Tamil Nadu and Kerala. It is in the south-eastern side of Canannore district and is located between 11° 49' and 11° 50' E. lat. and 75° 49' and 75° 57' N. long. It is about 55 sq. km in extent. Tropical wet evergreen forests form the major vegetation type. The area is drained by tributaries of perennial rivers Uruttipuzha and Cheenkannipuzha.

Methods

The study area was visited during February, 1995 and fishes were collected from five localities using cast nets, gill nets and scoop nets. Suitable conventional method of sieving by cloth and temporary bunding of tributaries were also employed in certain areas. Works of Day (1865, 1878), Jayaram (1981), Datta Munshi and Srivastava (1988), Talwar and Jhingran (1991) and Menon (1987, 1992) were referred for identification.

Results and Discussion

The survey indicates that the drainage system in Aralam is rich in fish diversity. A total of 33 species belonging to 15 families were collected from 5 localities (Table 1). Most of these are widely distributed in Kerala and other parts of Western Ghats. *Garra mullya, Barilius bakeri* and *Danio aequipinnatus* were the commonest and uniformly distributed fishes in Aralam Wildlife Sanctuary. *Puntius denisonii, Salmostoma acinaces, Mystus cavasius, Ompok bimaculatus, Clarias dussumieri dussumieri, Parambassis thomassi, Etroplus suratensis, Channa marulius* and *Anguilla bengalensis bengalensis* were comparatively rare and confined to Cheenkannipuzha, the major river system of Aralam Wildlife Sanctuary.

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[1] Accepted June 1995.

[2] Division of Wildlife Biology, Kerala Forest Research Institute, Peechi-680 653, Trichur, Kerala.

Table I

SPECIES WISE DISTRIBUTION OF FISHES IN DIFFERENT LOCALITIES IN ARALAM WILDLIFE SANCTUARY

Species	Cheenkanni-puzha	Valayamchal	Narikadavu	Chavachi-thodu	Uruttipuzha	Iyknam-thodu	Kurukka-thodu	Total No. of specimens	SL (in mm)
Family : Cyprinidae									
Sub-family: Cyprininae									
1. *Puntius filamentosus* (Val.)	3	3	-	-	2	-	-	8	85-130
2. *P. denisonii* (Day)	1	-	-	-	-	-	-	1	101
3. *P. ticto ticto* (Ham.)	-	2	-	-	2	-	-	4	36-48
4. *P. curmuca* (Ham.)	9	-	-	-	-	-	-	9	152-197
5. *P. melanampyx melanampyx* (Day)	9	3	-	-	-	-	-	12	61-62
6. *P. amphibius* (Val.)	-	3	-	-	-	-	-	3	94-99
7. *Osteochilus nashii* (Day)	3	4	3	-	-	-	-	10	75-137
8. *Tor khudree* (Sykes)	6	3	1	-	-	-	-	10	75-165
Sub-family: Cultrinae									
9. *Salmostoma acinaces* (Val.)	1	-	-	-	-	-	-	1	123
Sub-family: Rasborinae									
10. *Rasbora daniconius daniconius* (Ham.)	12	8	1	9	-	-	-	30	82-122
11. *Barilius bakeri* Day	16	12	7	1	9	1	6	52	71-114
12. *Danio aequipinnatus* (McClelland)	11	7	19	1	2	1	8	49	56-90
Sub-family: Garrinae									
13. *Garra mullya* (Skyes)	29	4	7	11	8	7	1	67	87-132
Family: Homalopteridae									
14. *Bhavania australis* (Jerdon)	13	-	-	-	-	-	3	16	35-70
Sub-family: Noemacheilinae									
15. *Noemacheilus triangularis* Day	10	6	2	-	-	-	1	19	46-69
16. *N. guentheri* Day	7	2	-	-	1	-	6	16	43-81
17. *N. nilgiriensis* (Menon)	-	-	-	-	-	-	11	11	32-42
Family: Bagridae									
18. *Mystus malabaricus* (Jerdon)	1	-	-	1	-	-	1	3	110-140
19. *Mystus cavasius* (Ham.-Buch.)	1	-	-	-	-	-	-	1	71

TABLE 1 (contd.)

Species	Cheenkanni-puzha	Valayamchal	Narikadavu	Chavachi-thodu	Uruttipuzha	Iyknam-thodu	Kurukka-thodu	Total No. of specimens	SL (in mm)
Family: SILURIDAE									
20. *Ompok bimaculatus* (Bloch)	1	-	-	-	-	-	-	1	80
Family: SISORIDAE									
21. *Glyptothorax madraspatanum* (Day)	9	-	-	-	-	-	-	9	53-81
Family: CLARIIDAE									
22. *Clarius dussumieri dussumieri* (Val.)	1	-	-	-	-	-	-	1	124
Family: BELONIDAE									
23. *Xenentodon cancila* (Ham.-Buch.)	1	1	-	-	-	-	-	2	58-191
Family: CYPRINODONTIDAE									
24. *Aplocheilus lineatus* (Val.)	1	-	1	-	1	-	-	3	40-52
Family: AMBASSIDAE									
25. *Parambassis thomassi* (Day)	1	-	-	-	-	-	-	1	91-101
Family: NANDIDAE									
26. *Pristolepis malabarica* (Gunther)	3	-	-	-	-	-	-	3	80-82
Family: CICHLIDAE									
27. *Etroplus suratensis* (Bloch)	1	-	-	-	-	-	-	1	101
Family: CHANNIDAE									
28. *Channa marulius* (Ham.-Buch.)	1	-	-	-	-	-	-	1	157
29. *C. orientalis* (Schneider)	6	5	-	-	-	-	-	11	62-91
Family: MASTACEMBELIDAE									
30. *Matacembelus guentheri* Day	3	2	-	-	-	-	-	5	76-84
31. *Mastacembelus armatus armatus* (Lacepede)	5	2	-	-	-	-	-	7	150-256
Family: ANGUILLIDAE									
32. *Anguilla bengalensis bengalensis* (Gray)	1	-	-	-	-	-	-	1	380
Family: GOBIIDAE									
33. *Sicydium fasciatum*	3	-	-	-	-	-	-	3	52-725

Osteochilus nashii which has originally been reported from the east flowing Cauvery river system is reported for the first time from a west flowing river system. *Puntius denisonii* (Day) has so far been reported only from the Travancore hills (Day 1865). Later, Silas (1951) reported the species from the hill ranges of Anamalai and Nelliampathy. The present observation of *Puntius denisonii* (Day) from Aralam Wildlife Sanctuary indicates its range of extension to the north of Palghat gap. *Noemacheilus nilgiriensis* (Menon) has been reported only from Pykara Dam, Nilgiri District, Tamil nadu (Menon 1987). The present survey reports its occurrence for the first time in a west flowing river in Kerala.

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IMPACT OF SALT WORKS ON THE STATUS, POPULATION OF THE GREATER FLAMINGO *PHOENICOPTERUS RUBER ROSEUS* AND THE LESSER FLAMINGO *PHOENICONAIAS MINOR* IN THE GREAT VEDARANYAM SWAMP[1]

Ranjit Manakadan[2]

(*With three text-figures*)

Key words: greater flamingo, lesser flamingo, Great Vedaranyam swamp, salt water, *Tilapia*

The status, population, seasonal fluctuations, distribution of the greater flamingo and the lesser flamingo in the Great Vedaranyam Swamp are discussed. The impacts of salt works on the two species was investigated. Both species are migrants to the Swamp, but their area of origin is uncertain. Peak population of the greater flamingo was recorded during the North East Monsoon. The arrival and stay of the lesser flamingo was erratic. Interannual variations in the numbers occurred for both the species. The impact of salt works differed according to the species, and varied both spatially and temporally.

INTRODUCTION

A great deal of work has accumulated on various aspects of the biology, ecology and ethology of flamingos (e.g. Kear and Duplaix-Hall 1975, Johnson 1983, 1989). However, no detailed long term studies have been undertaken on flamingos in the Indian subcontinent, and most of the available literature give anecdotal accounts (e.g. McCann 1939, Ali 1945, 1974; Mundkur *et al.* 1989). Flamingos inhabit highly alkaline and saline lakes and are considered to be partial to salt works (Ali and Ripley 1983). However, the extent of their partiality to salt works, the type of salt works and microhabitats preferred within salt works has not been investigated. This papers deals with the populations and seasonality of flamingos of the Great Vedaranyam Swamp, and assesses the impact of salt works on them.

STUDY AREA

The Great Vedaranyam Swamp (henceforth referred to as GVS) is one of the largest (*c.* 349 sq. km) and major wintering grounds for waterbirds in South India (Ali 1963). It forms a major part of the Point Calimere Wildlife and Bird Sanctuary, Nagapattinam Quaid - e - Milleth district, Tamil Nadu state. Its camp headquarters is situated at Kodikkarai (10° 18' N, 79° 51' E), where this study was concentrated (Fig. 1).

The habitat of the GVS is varied. It has a mangrove lined lagoon in about one-third of its western portion. The other two-thirds is a continuous sheet of shallow, fresh/brackish/saline water during the monsoon and during the period of the south westerly winds. As this water spread dries up, 'flats' are created, and during very dry periods, there is water only in the Seruthalaikkadu Creek. The GVS is connected to the Palk Strait by a few openings or breaches. Waters of the River Cauvery empty into the GVS during the NE. Monsoon period through seven channels.

Salt works: Three industrial salt works and a number of small and large scale edible salt works operate in the GVS, and are concentrated mainly around Agastiyampalli.

Industrial salt works are heterogeneous in nature with a system of reservoirs (for storage and partial condensation of brine), condensers (condensation of brine) and crystallizers (harvest pans). This process gives 99% pure salt (sodium chloride). The 'liquor' left after the extraction of sodium chloride is called bittern, and is either considered a waste product, or forms the raw material for salt based chemical units.

On the other hand, edible salt works are

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[1] Accepted November 1993.

[2] Bombay Natural History Society, Hornbill House, Dr. Sálim Ali Chowk, Shaheed Bhagat Singh Road, Bombay-400 023.

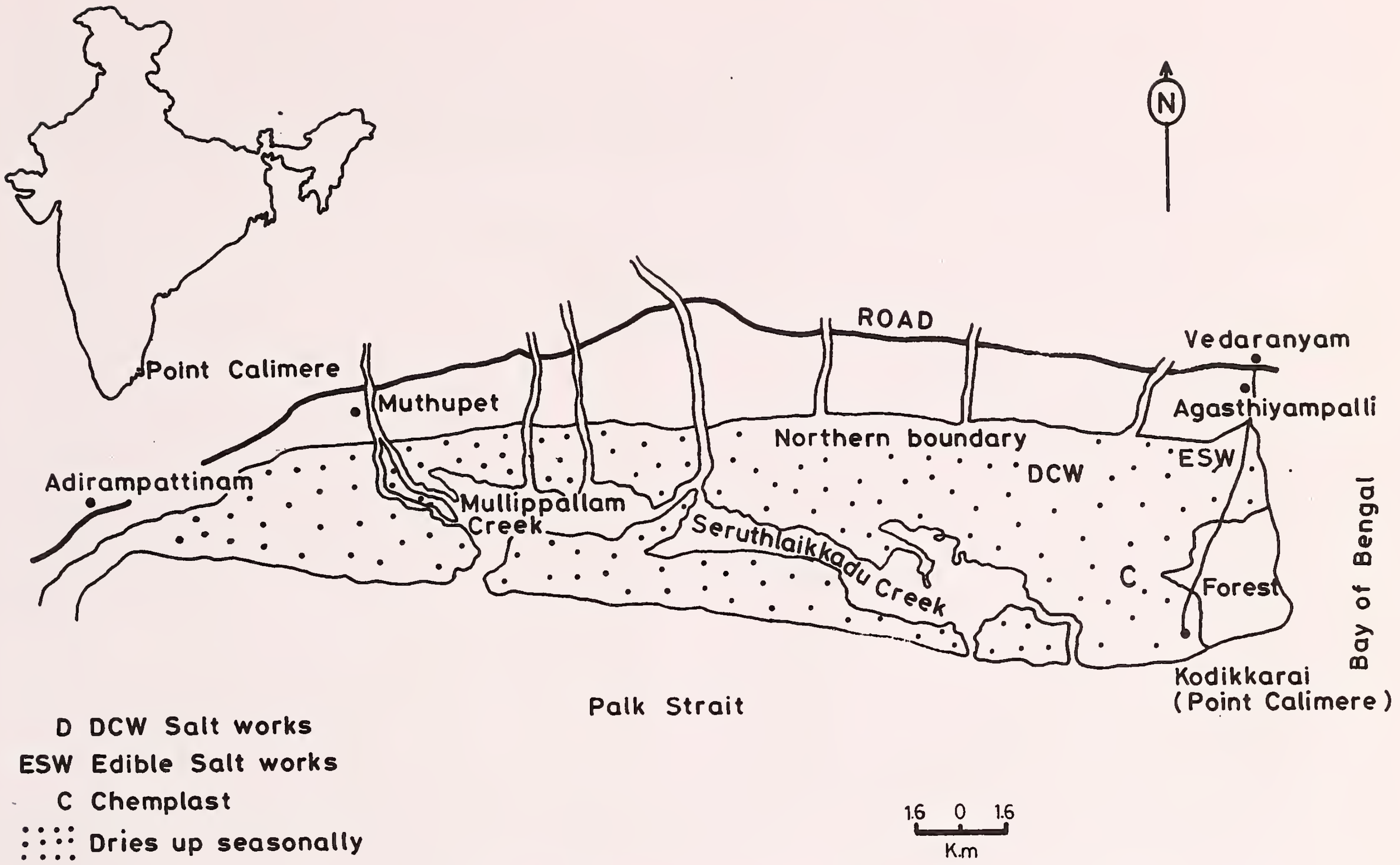
N
ROAD
Vedaranyam
Point Calimere
Muthupet
Agasthiyampalli
Northern boundary
ESW
Adirampattinam
DCW
Mullippallam Creek
Seruthlaikkadu Creek
C
Forest
Bay of Bengal
Kodikkarai (Point Calimere)
Palk Strait
D DCW Salt works
ESW Edible Salt works
C Chemplast
Dries up seasonally
1.6 0 1.6
K.m

Fig. 1. Map of the Great Vedaranyam Swamp.

homogenous in nature and composed almost entirely of crystallizers, and the salt obtained by this method has impurities of calcium carbonate, calcium sulphate and salts of magnesium and potassium.

The salt season in the GVS (and the south east coast of India) is January to September. In general, during the season, salinity is lowest in the reservoirs (35-70 ppt), followed by condensers (70-230 ppt) and highest in crystallizers (240-280 ppt). Conversely, water depth is maximum in reservoirs (*c.* 40 cm), comparatively lower in condensers (*c.* 20 cm) and minimum in crystallizers (*c.* 5 cm). It should be noted that the salinity and water depth in reservoirs and condensers, besides varying from reservoir/condenser to reservoir/condenser, will again vary within itself according to the stage (early, peak and late) of the salt season. But habitat parameters in crystallizers are more or less stable temporally and spatially. The temperature of the water increases with an increase in salinity and decreases with water depth. The pH value decreases with increasing salinity due to the deposition of carbonates. Human disturbance is high (40 workers 1 sq. km) in crystallizers.

The off-season is during the NE. Monsoon period, during which, there is heavy influx of fresh water into the salt works due to the rains. Salinity falls markedly (to *c.* 10 ppt) over the whole complex. The sluice gates are opened to prevent/reduce damage to the earthern dykes and drain the complex of the low salinity water. During this time, salt works are again connected to the natural habitat. Water depth and spread in salt works depend on the stage of the monsoon — deep water during heavy rains and low water levels during dry spells (See Landry and Jaccard 1982, Britton and Johnson 1987 and Manakadan 1992 for more details).

METHODOLOGY

Total counts of greater flamingo and lesser flamingo were undertaken over an area of 19 sq. km near Kodikkarai. This area encompassed all the

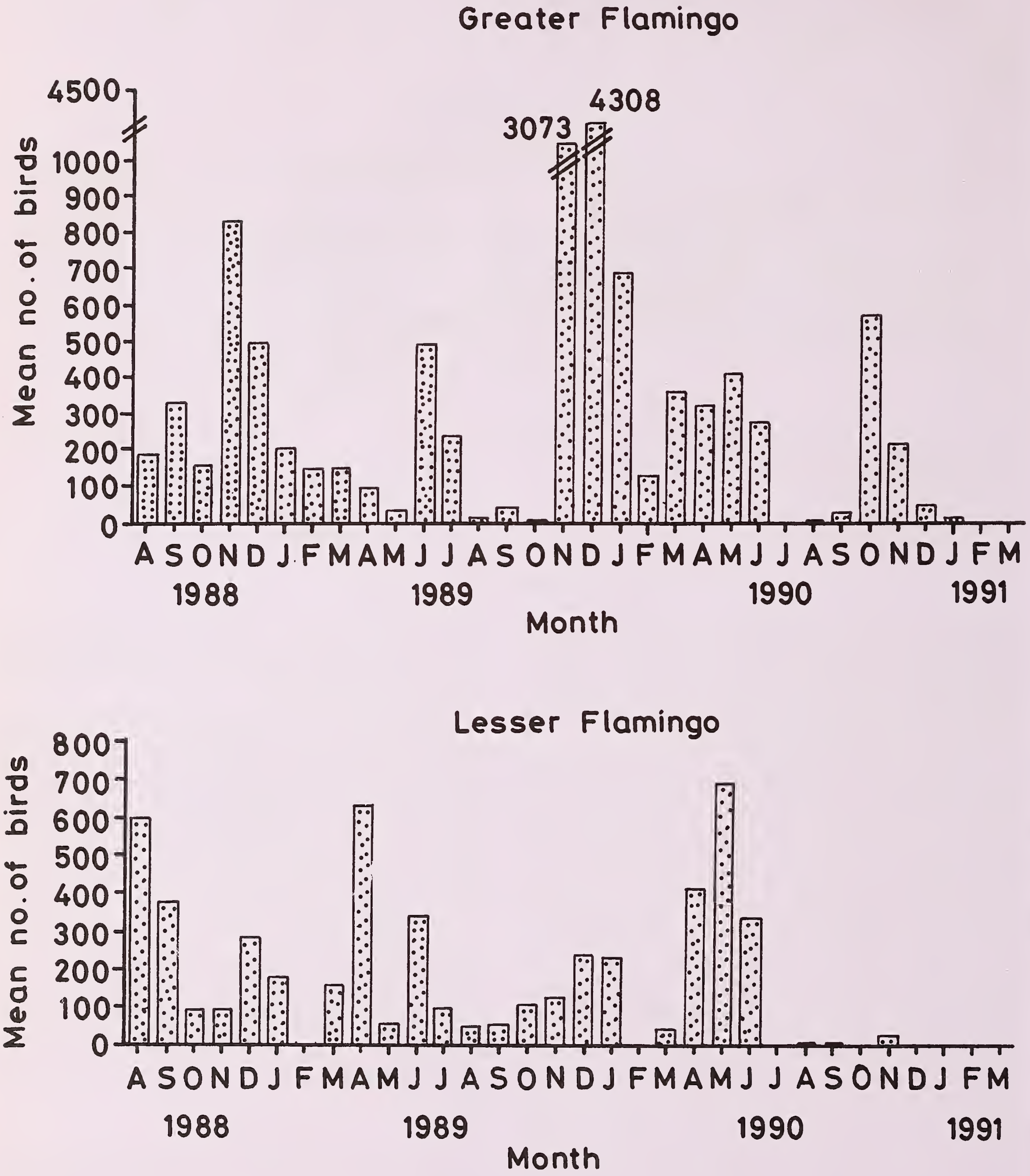

Fig. 2. Population of flamingos.

reservoirs, crystallizers and condensers of a salt work, and part of the adjoining natural habitat. Counts were done thrice a week and were conducted between August 1988 to March 1991. Accessibility to the area was by motorbike or on foot, using the dykes of the salt works. A general idea of the flamingo numbers and distribution in other parts of the GVS was obtained by occasional boat surveys and from local enquiries.

RESULTS

The greater flamingo numbers showed a marked rise in populations around the monsoon period for all the years (Fig. 2). Inter-annual fluctuations were evident, with maximum of 1650 birds in 1988, 8762 in 1989 and 676 in 1990. It was recorded in the GVS throughout the study period, except for October 1990 and March 1991. No seasonal trends were seen in the case of the lesser flamingo (Fig. 2). There were irregular monthwise fluctuations. Birds were not recorded in some months, the maximum count of 1050 birds was recorded in April 1989.

From the boat surveys and local enquiries, it appears that the flamingos are concentrated around the study area (Kodikkarai — Kodikkadu part). There was only one sighting of a flock of 300 odd lesser flamingo about 15 km west of the study area during the boat surveys. Flamingos do not frequent/ are rare in the western mangrove part of the GVS. Concentration of flamingos at the study area is probably due to the comparatively lower levels of poaching/disturbance here, due to good protection.

The greater flamingo frequented the natural habitat during the hot months or peak salt season (April-September) — except in 1989, when some birds were recorded in salt works (Fig. 3) There is a partial shift of population: 86% in 1988-89, 22% in 1989-90, 37% in 1990-91 into the salt works during the NE. Monsoon and the differences between the populations in habitats was significant for the 1989-90 season (Mann Whitney U test = 9.5, P=0.01). The birds frequent the salt complex till the early salt season or post monsoon (January till March) — 82% in 1988-89, 25% in 1989-90 and 75% in 1990-91). During their stay in salt works, significantly more birds frequented reservoirs than condensers during the 1988-89 season (U=349, p=0.001), and were recorded only in reservoirs during the 1990-91 seasons. The greater flamingo was not recorded in crystallizers. Low and contrasting values for salt works during the 1989-90 period are as follows: Just prior to the monsoon, a breach occurred in the effluent canal. This resulted in the bittern being pumped into the reservoir along with the brine — till the breach was finally plugged after three days. This caused massive kills of fish and other organisms in the reservoirs. These deaths could have prevented 'normal' build-up of prey populations as in the other years.

The lesser flamingo was partial to the natural habitat and was not recorded in salt works, except during the monsoon and post monsoon of the 1988-89 season (Fig 3). During these two cases, birds were recorded only in the reservoirs — not in condensers or crystallizers.

DISCUSSION

1. Status, seasonality and populations:

The origin of the two flamingo species of the GVS is uncertain. The earlier general presumption that they originate from Kutch has been belied by the recovery of Iranian and Russian ringed greater flamingos from the GVS [BNHS (Bird Migration Studies): unpublished data]. Major banding studies showed migration of greater flamingos from Russia to Iran during extreme cold weather (Cramp and Simmons 1977) and from Iran to the Indian subcontinent (Cramp and Simmons 1977, Johnson 1989). The lesser flamingo is presumed to be of African origin since little breeding has been recorded in India (Cramp and Simmons 1977, Ali and Ripley 1983). No information has come from the hundred odd birds (majority of them greater flamingo) ringed in the GVS by the BNHS, nor the 192 greater flamingo young ringed in Kutch (Ali 1945).

Earlier accounts of flamingos from the GVS (Ali 1963, 1986; Spillett 1969, Ali and Hussain 1981, Ali and Sugathan 1985) suggest wide seasonal and

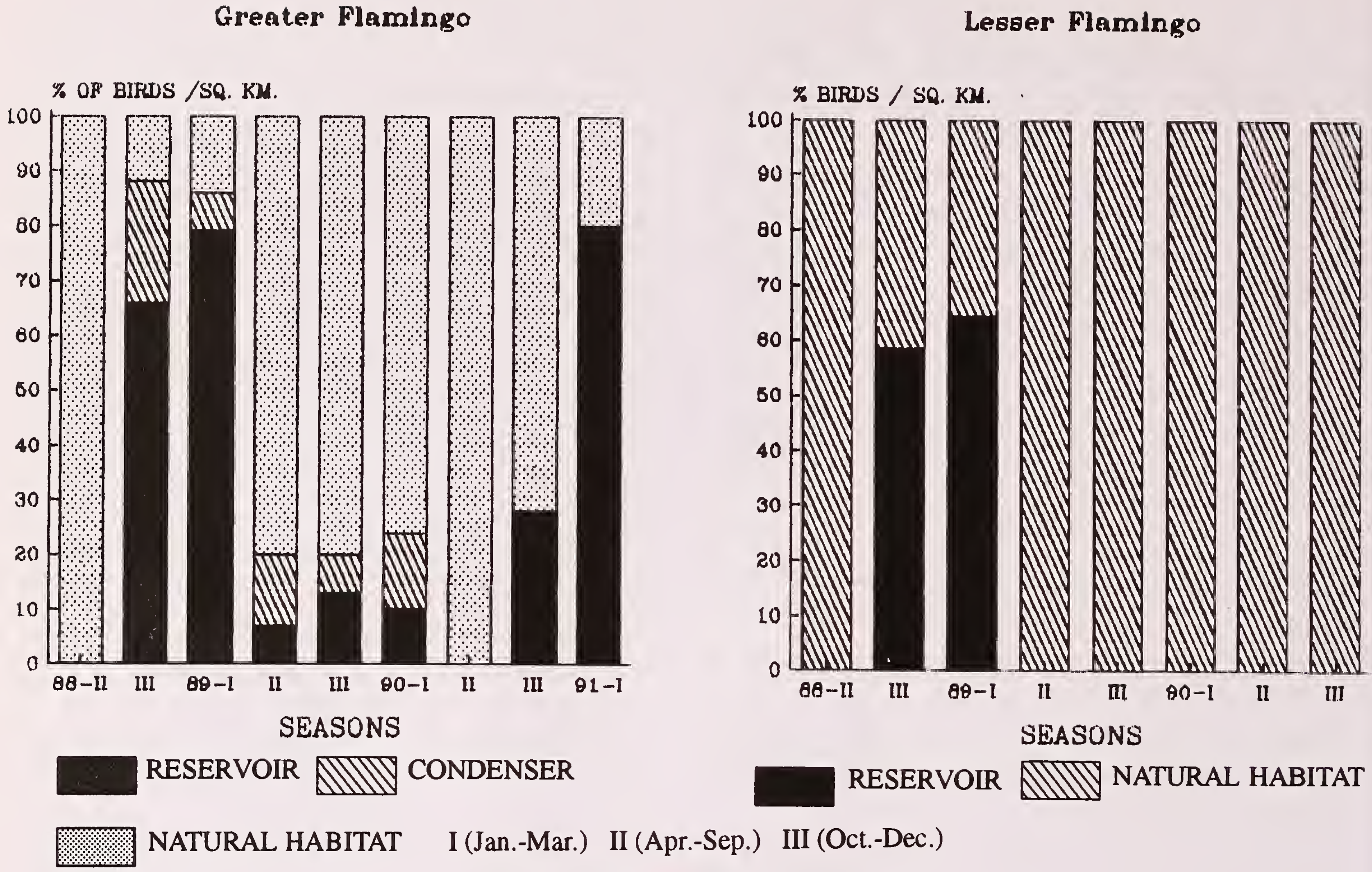

Fig. 3. Habitat utilisation by flamingos.

annual variations in the number of flamingos, as was recorded during this study. Erratic movements in flamingos are well known (Cramp and Simmons 1977, Brown *et al.* 1983, Johnson 1989), in addition to individual differences in movement pattern (Johnson 1989). The greater flamingo appears to be largely a monsoon visitor to the GVS, as reported for South India (Biddulp 1938) and Sri Lanka (Hoffmann 1989). The movements of the lesser flamingo in the GVS is similar to that described by Brown *et al.* (1983) for Africa — "sedentary for some months — then moving to other haunts."

2. Impact of salt works:

Salt works are known to be attractive to the greater flamingo during heavy rains (Connor 1980). There are two likely reasons for the shift of the greater flamingo into salt works during the monsoon in the GVS: (1) increased food supplies in salt works and (2) decreased food supplies in the natural habitat.

The favourable season for most animal communities in salt works and saline lakes is during the rainy season (Baid 1968, Mahoney and Jehl 1985, Britton and Johnson 1987). The same has been documented in the case of benthic fauna in the salt works studied (Sampath 1989), who also found the productivity to be higher in reservoirs than condensers and the natural habitat during the same period. This explains the shift of the greater flamingos into salt works (and to a greater degree into reservoirs) from the natural habitat during the monsoon. In contrast, the inflow of fresh water into the natural habitat kills off the estuarine forms as known in studies on estuarine systems (e.g. Flint and Rabalais 1981, Kalke 1981, Mathews 1981). This was found true for plankton and benthic fauna of the GVS (Anbazhagan 1989 and Godfred 1992), though not supported by Sampath's (1989) studies. Hence, a combination of increased food availability in salt works combined with decreased prey availability in the natural habitat, is responsible for the shift of greater flamingo from the natural habitat into the salt works.

As the unfavourable conditions return to salt works with the onset of the salt season, the greater flamingo returns to the natural habitat. Meanwhile, food supplies too have increased in the natural habitat due to the return of estuarine conditions (Anbazhagan 1989, Godfred 1992). But, the availability of salt tolerant species in salt works or saline lakes, that can occur in high densities due to absence of predators like fish (Mahoney and Jehl 1985) has to be considered. In very high salinity condensers (or habitats), Ephydrid larva becomes inaccessible to the greater flamingo due to the crust of gypsum formed in the beds (Hurlbert and Keith 1979, Rooth 1982). With regard to *Artemia* — another salt tolerant form and favoured food of the greater flamingo (Cramp and Simmons 1977, Ali and Ripley 1983, Britton *et al.* 1986) — its abundance is during favourable conditions, i.e. moderate salinity (Baid 1968, Mahoney and Jehl 1985, Sampath 1989). And finally, since the greater flamingo's diet is made up of largely animal than plant matter (e.g. Jenkin 1957, Cramp and Simmons 1977, Ali and Ripley 1983, Brown *et al.* 1983), the abundance of algae in high salinity areas of salt works are not particularly attractive to them.

The lesser flamingo's diet is largely composed of blue-green algae and diatoms, and it is considered to be more partial to highly saline and alkaline lakes than the greater flamingo (Jenkin 1957, Cramp and Simmons 1977, Ali and Ripley 1983, Brown *et al.* 1983). I suggest two reasons for their avoidance of salt works in this study, though saline lakes/salt works are known to be rich in algal production (Barnes 1980, Borowitzka 1981, Hammer 1981, Brock and Shiel 1983): (1) water depth and (2) presence of a food competitor.

In this study, the lesser flamingo was recorded to feed in very shallow water (< 5 cm). This water depth is generally available in many areas of the natural habitat — except in the Seruthalaikkadu Creek and during the peak monsoon period. In salt works (except for crystallizer), shallow water is limited to the edges of the reservoirs and condensers when water levels are low. To cite an example of preference for shallow water, during all the few sightings in salt works, they fed at the edges of the reservoirs or while standing on a submerged abandoned dyke of the first reservoir. The lesser flamingo is known to swim and feed in deep water, but this occurs in still water (Kahl 1970, Cramp and Simmons 1977, Brown *et al.* 1983), otherwise, the birds group and form 'rafts' to still the water. I presume such a foraging strategy is unsuitable in the GVS, due to the prevalence of windy weather because of the coastal location and effect of tides (versus inland lakes in Africa) and the absence of huge flocks or populations, as seen in Africa to be able to 'calm' the water (see Kahl 1970 and Brown *et al.* 1983). In the case of crystallizers, the presence of workers and the predominant occurrence of unicellular forms of algae (see Baid 1968, Borowitzka 1981, Jones *et al.* 1981, Brock and Shiel 1983), that the lesser flamingo is not able to extract for food (Vareshi 1978), are deterrents inspite of its shallowness.

Though often overlooked, strong competitive interactions among distantly distributed organisms is widespread (see Hurlbert *et al.* 1986). A factor known to limit flamingo populations is fish — by competing for the same prey. There seems to be a strong positive correlation between the absence of fish and flamingo populations (Ridley 1954, Hurlbert *et al.* 1986). Though Vareshi (1978, 1979) found no detectable impact on introduction of *Tilapia grahmani* in Lake Nakuru on the lesser flamingo (though both fed on a common food base), Brown *et al.* (1983) considered the introduction responsible for non-occurrence of previously recorded huge populations of the lesser flamingo. In this study, it was found that the exotic fish *Tilapia mossambicus* is concentrated in the low salinity condensers (recorded till 100 ppt). Reasons for its abundance in low salinity condensers is probably due to abundance of blue-green algae (which predominates in this salinity range — Borowitzka 1981), as blue green algae is the main or favoured food of *Tilapia mossambicus* (see Abayasiri and Costa 1978). Hence, in addition to water depth, the lesser flamingo avoided low salinity condensers due to the presence and abundance of a food competitor.

CONCLUSION

In the case of the greater flamingo, reservoirs and low salinity condensers offer an important source of food during the monsoon and post-monsoon period. The greater flamingo largely avoids salt works during the peak salt season (April to September). Crystallizers are avoided throughout the year. To the lesser flamingo, salt works result in an almost total loss of habitat.

The main reason for these differences in impacts on the two species is that the greater flamingo is a generalist feeder and can shift to feeding on the different species of prey, where and when abundant. On the other hand, the lesser flamingo is a specialist feeder of blue green algae. This dependance on a very narrow food base, restricts it from opportunistic feeding on other abundant organisms, unlike in the case of greater flamingo.

An interesting finding is that industrial salt works are more attractive to flamingos (and other birds) than edible salt works. This is because industrial salt works are heterogenous in nature and provide a varied mix of physical, chemical and biological conditions, to suit the diet or foraging strategy of the bird species. On the other hand, edible salt works are homogenous in nature and offer very harsh and non-diverse conditions almost throughout the year for most bird species.

Finally, it has to be stressed that the findings are applicable to salt works on the south-east coast of India. Habitat conditions and impacts could differ significantly in other areas. For example, while the peak season of flamingos coincides with the off-season of salt works in the GVS, the same period (October-December) is the peak salt season for salt works on the west coast of India — as the rainy season on the west coast is during June-September (SW. Monsoon).

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ECOLOGY AND TAXONOMY OF THE FIELD MICE IN THE ARAVALLI RANGES[1]

ISHWAR PRAKASH,[2] A. SARAVANAN[3] AND PARTAP SINGH[3]

Key words: Aravalli ranges, *Mus phillipsi, M. platythrix, M. saxicola, M. terricolor,* ecology, reproduction, taxonomy

Small mammals were trapped every month during 1993 from various habitats at different altitudes of the Abu hill situated on the southern region of the Aravalli ranges. In 0.25 million trap hours, along other mammals, 61 mice specimens were collected. Detailed analysis of the vegetation and soil types, reveal that *Mus platythrix* and *Mus saxicola sadhu* prefer habitats with soil base whereas *Mus phillipsi* is a rock dwelling species. The canopy cover had no apparent relationship with them but grass patches even on higher altitudes were preferred. *Mus terricolor,* being reported for the first time from Rajasthan State, was found in flat scrublands in the foothills. *Mus platythrix* was relatively abundant at an higher altitude, 1500-1600 m whereas *M.s. sadhu* was more prolific in the foothills and *Mus phillipsi* occurred at all the elevations.

The prevalence of pregnancy in all *Mus* species was found to be rather low. Pregnant *M. s. sadhu* were found from April to September, litter size being 5.4, range 2-9. On the basis of cranial characters, a key to determine *Mus* species is presented.

INTRODUCTION

The Aravalli ranges diagonally bisect the State of Rajasthan into a western arid region and the eastern semi-arid zone. The western desert, the Thar, is continued into a chain of deserts constituting the great Saharo-Tharian plain. The Aravalli range is a geographical barrier for the xeric fauna for spreading towards the east, into the Oriental region. It is, however, a pathway for the Deccanian elements to invade the desert through its western foothills. Inspite of its interesting zoo-geographical location and archaic rock formation, very little work has been carried out on its faunal diversity. We trapped small mammals all the year round at various altitudes and in different habitats. The results of our study on the ecology and taxonomy of mice are presented in this communication.

THE STUDY AREA AND METHODS

The Abu hill is situated on the southern region of the Aravalli ranges in the Sirohi district of Rajathan. It presents a variety of habitats at various altitudes with a clear stratification of vegetation types. On the basis of evaluation of altitude, terrain, soil and vegetation we identified five habitats for this study. During 1993, small mammals were collected every month from these habitats by fixing two trap lines of 30 traps in every habitat. Snap traps were spaced at a distance of 10 metres in each trap line. In all more than 300 snap traps were laid every month and were run for 72 hours. The trapped specimens were measured, numbered by toe-clipping method and preserved in formaldehyde. Skulls were prepared and measured. Specimens were identified following keys provided by Wroughton (1918), Ellerman (1947, 1961) and Marshall (1977).

RESULTS

In about 2,59,200 trap hours a large number of small mammals were collected out of which 61 specimens of mice have been assigned to four species.

Fawn coloured spiny mouse *Mus phillipsi* Wroughton, 1912

This spiny mouse occurs in all the habitats of the Abu hills inclusive of the runnels. Except for one specimen which was collected from low scrubland near rocky outcrops, all others (95%) were

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[1] Accepted February 1994.

[2] INSA senior Scientist, Zoological Survey of India, Jodhpur 342 009.

[3] Junior Research Fellow, DST Project on Community Ecology of small mammals in the Aravallis, Zoological Survey of India, Jodhpur-342 009.

collected from rocky habitat. This mouse appears to be typically a rock dweller. In various districts of the Thar desert, it was reported from hills only and associated with *Euphorbia caducifolia* (Prakash *et al.* 1971). In the Aravalli hills it also occurs in runnels (16%) which have a poor vegetation cover and in rocky regions with sparse vegetation (68 %) as compared to localities with dense vegetation (10 %; Table 1). *Mus phillipsi* was more common in regions with *Euphorbia neriifolia* shrubs. It was uniformly distributed at all the altitudes (Table 1).

TABLE 1

HABITAT PREFERENCE OF FIELD MICE IN THE ARAVALLI RANGES

		Mus phillipsi	*Mus platythrix*	*Mus saxicola*	*Mus terricolor*
Stonewall		—	30.8	7.4	—
Runnel		15.8	—	—	—
Scrubland	Foothill	5.3	15.4	18.5	100
	High Elevation	—	23.1	11.1	—
Rocky with dense Vegetation		10.5	15.4	22.2	—
Rocky with sparse Vegetation		68.4	15.4	40.7	—

Note: The values are denoted in percentage.

Mus phillipsi from the Aravallis is slightly larger in size as compared to those examined by Marshall (1977).

	Aravalli Collection		Marshall,
	Male	Female	1977
Head & Body	76.0±7.04	71.4±8.6	73.5±7.4
Tail	60±5.7	56.3±7.7	58.5±4.0
Hindfoot	13.9±1.0	14.2±1.5	15.0±0.9
Body weight	14.83±4.71	11.0±4.0	12.3±2.9
ON*	21.7±1.0	21.4±1.2	22.37±0.47
PF**	5.25±0.5	4.9±0.45	5.0±0.26
Upper Molar length	3.7±0.41	3.6±0.24	3.72±0.22

* Occipitonasal length. ** Length of palatine foramina.
All measurements are in millimetres and grams.

Brown spiny mouse *Mus platythrix*
Bennett, 1832

The largest of the four mice possessing fur with distinct spines scattered all over the dorsal side. It was trapped from various habitats (Table 1) and altitudes (Table 2) and occupied flat areas over the hills and loosely piled stone walls around the crop fields. In the rocky habitat it was found in places where soil deposits were present in which their burrows were located.

The near vicinity of its burrows was covered by ground hugging vegetation like *Cyperus rotundus, Cynodon dactylon, Cymbopogon martinii,* etc. Spiny mice were collected in equal number from rocks with and without dense tree vegetation (Table 1), it appears that its distribution is not largely affected by canopy cover. In the scrublands, it was more abundantly found at higher altitudes, 1500 metres as compared to the foothills. 61 % *M. platythrix* were collected at 1500 m altitude (Table 2).

The Aravalli specimens are smaller in size as compared to those examined by Marshall (1977) but were heavier in body weight.

	Aravalli Collection		Marshall,
	Male	Female	1977
HB	105±3.0	102.0	107±10.9
Tail	75±2.6	70.0	77±3.9
HF	16.2±0.9	14.0	18.5
B.Wt.	32.0±8.1	32.0	18.0
ON	25.5±0.9	24.5	27.36±0.98
PF	6.5±0.4	6.0	5.92±0.26
Upper Molar	4.1±0.2	4.0	5.10±0.26

Marshall (loc. cit.) mentions in the key that *M. platythrix* possess 3+2 mammae but two specimens of this species from the Aravallis possess 4+2 mammae. These specimens were assigned to *M. platythrix* on the basis of shorter palatine foramina which is considered a more stable character for identification as compared to the number of mammary glands. Ellerman (1961) has also reported variations in numbers of mammae in *M. platythrix.*

TABLE 2
ALTITUDINAL DISTRIBUTION OF FIELD MICE IN THE ARAVALLI RANGES

	Mus phillipsi	*Mus platythrix*	*Mus saxicola*	*Mus terricolor*
Abu Road and Anadra (150 m)	21.0	30.8	59.2	100
Chhepaberi (500 m)	36.8	—	3.7	—
Arna and Gomukh (1000-1100 m)	15.8	7.7	14.8	—
Mt. Abu (1500-1600 m)	26.3	61.5	22.2	—

Sadhu mouse *Mus saxicola sadhu*
Wroughton, 1911

Out of the four mice species collected, the sadhu mouse was the commonest (44.2 %). It occupied all the habitats except the runnels (Table 1) and occurred at all altitudes (Table 2). However, it was more abundant in the rocky habitat (62.9 %) and in flat scrublands (29.6 %) whether on foothills (18.5 %) or at higher elevations (11.1 %). Surprisingly, their occurrence was significantly more (P <0.001) in rocky areas with sparse vegetation (*Euphorbia-Lantana* on eastern side of Abu hill and *Butea monosperma-Wrightia tinctoria-Aegle marmelos* on the western side) as compared to those with dense vegetation (*Butea monosperma, Anogeissus pendula/latifolia, Eugenia jambolana, Moringa concanensis, Aegle marmelos, Carissa carandas*). We studied in detail a few specific sites from which *M. s. sadhu* were trapped and it appears that the presence of soil deposits over rocks is its major shelter requirement. This was probably the reason it occurred in flat areas even at an altitude of 1500-1600 metres. In the scrublands, its burrows were located under herbacious cover. Small pebbles were seen arranged around two burrow openings. One male *M.s. sadhu* had arranged the faecal pellets of the blue bull, *Boselaphus tragocamelus* around three openings of its burrow system under a tree, *Prosopis spicigera* at Anadra. Two specimens were collected near the stone wall around crop fields at an altitude of 1600 m. One male *saxicola* was collected from a decaying log of *Butea monosperma.* Maximum number (59 per cent) of this species was collected at the foothills (Table 2). One of the specimens (July-47) bears 5 + 2 pairs of mammae whereas other females possess the normal number 4 + 2 pairs.

Like *M. platythrix,* the specimens collected from the Aravalli region were smaller in size than those examined by Marshall (loc. cit.)

	Aravalli Collection		Marshall, 1977
	Male	Female	
HB	87.8±5.1	85.4±10.3	88.7±10.5
Tail	72.4±7.9	66.6±6.4	71.7±6.9
HF	17.0±0.5	16.0±0.7	18.16±1.17
B.Wt.	21.8±3.2	20.1±4.9	21.4±4.9
ON	24.1±1.1	23.0±1.3	24.77±0.93
PF	6.1±0.37	5.8±0.4	5.91±0.32
Upper Molar	4.4±0.38	4.0±0.3	4.36±0.23

Small spiny mouse *Mus terricolor*
Blyth, 1851

Only two specimens were collected from the grassland situated on plains at the foothills of Aravallis. One of them was captured from a burrow among the root system of *Cassia fistula* around 4 p.m. One of the females had perforate vagina so we considered it to be an adult. The specimens have been assigned to *M. terricolor* as they are too small to be *M. booduga* (reported earlier from Mt. Abu by Ryley 1913) or *M. dunni.*

The body measurements of Aravalli specimens are closely similar to *M. terricolor.* This species is reported for the first time from Rajasthan.

	Aravalli Collection		Marshall, 1977
	Male	Female	
HB	48.0	52.0	57.6±4.6
Tail	50.0	51.0	54.1±4.6
HF	12.0	13.0	14.28±0.54
B.Wt.	4.0	4.0	—
ON	17.0	17.0	17.64±0.58
PF	3.5	3.5	3.95±0.19
Upper Molar	3.0	3.0	3.04±0.17

Discussion

Relative abundance: An intensive trapping of small mammals on the Abu hill of Aravalli range has indicated that, amongst various mice species, the sadhu mouse, *Mus saxicola* is by far the most abundant species followed by the fawn coloured spiny mouse, *Mus phillipsi* and the brown spiny mouse, *Mus platythrix. Mus terricolor* occurs on the foothills in very low number.

Habitat preference: Rocky habitat with sparse tree density but with good ground vegetation supports maximum population of mice (42.6%) and are more or less equally shared by *M. saxicola* and *M. phillipsi* (Table 1).

Rocks with dense tree density and scrubland on the foothills are the next in habitat preference of the mice. Loosely piled stone wall and runnels where three species except *M. terricolor* were collected, are again habitats with very low vegetation cover. This observation suggests that probably shelter to mice has a preference over the close vicinity of food, i.e. vegetation. These results also point out that excessive grazing and tree felling, thus denuding vegetation cover, may be one of the factors for creating a more preferred niche for the mice, resulting in increase of their population density. The detailed analysis of microhabitat from where mice were collected indicates that *M. saxicola* and *M. platythrix* prefer even rocky region with sufficient soil deposits which may be conducive to their burrowing habits. That is probably the reason that they were more prolific in flat deposits even at 1600 m altitude. *M. terricolor* was collected only from scrublands on the foothills.

Altitudinal distribution: It appears that the foothills are the most occupied habitat as 42.6 per cent mice were collected from this habitat (Table 2). Higher altitude (1500-1600 m) was the next in preference of mice and 31.1 per cent of the total mice were collected from these elevations. The mid altitudes were equally shared by them (13.1 % each, Table 2). *Mus saxicola sadhu* and *Mus terricolor* are more common at foothills. *Mus platythrix* occurred in higher numbers (61.5 %) at higher elevations whereas *Mus phillipsi* occurred in almost equal numbers at all the elevations.

Reproductive Biology: Some information could be gathered on the reproductive aspects of mice from the field collection. Whereas the male and female ratio in the trapped animals was almost equal in *M. phillipsi, M.s. sadhu* and *M. terricolor,* it was highly biased in *M. platythrix* as out of 13 specimens collected only two were females. This bias may be due to a higher exploratory and wandering propensity of males due to which their trapping frequency may be higher as compared to that of females.

The capture of *M.s. sadhu* and *Mus phillipsi* was well distributed over the year. Surprisingly, however, none of the eight females of *phillipsi* was found to be pregnant. Out of 8 females of *Mus s. sadhu,* five, collected during April to September, were pregnant, average litter size being 5.4, range 2 to 9.

Taxonomy: Identification of mice in India has been problematic ever since Jerdon's and Blanford's days, probably due to overlapping body and cranial measurements of various species. However, a fairly large number of species were grouped by Wroughton (1918) under three genera: *Mus* (house mice), *Legadilla* (frontal supra-orbital ridge well pronounced) and *Leggada* (essentially jungle mice). Later these were merged into a single genus *Mus* by Ellerman (1961), lumping all the former species into half a dozen species. The common mice found in the sub-continent were identified through a simple key:

1. Tail longer than head and body .... *Mus musculus*
2. Tail smaller than head and body.
    - i) Size large, HB 90-110 mm, occipitonasal length over 25 mm .... *Mus platythrix*
    - ii) Size medium, HB 75-80 mm, occipitonasal length less than 23 mm . *Mus cervicolor*
    - iii) Size small, HB up to 75 mm, occipitonasal length less than 20 mm .... *Mus booduga*

Later Marshall (1977) examined specimens of mice in various museums and on the basis of morphometric characters, karyotypes and the species of lice found on mice body revised the Asian species of *Mus.* He brought about three major changes: restricted *Mus cervicolor* to Nepal, Myanmar, Thailand, Laos, Vietnam; Sumatra and Jawa; re-erected the species *saxicola* (Elliot 1839) and regrouped the genus *Mus* into three sub-genera after rematching a large number of species described by Thomas (1921), Wroughton (1918) and other workers in the past:

Subgenus	Species
Pyromys	*shortridgei, saxicola, platythrix, phillipsi, fernandoni.*
Coelomys	*mayori, pahari, famulus, crociduroides, vulcani.*
Mus	*caroli, cervicolor, musculus, cooki, booduga, dunni, terricolor.*

In his revision, out of the six subspecies recognised by Ellerman (1961) under *Mus cervicolor,* Marshall (loc. cit.) shifted *fulvidiventris* under the species *Mus booduga* as its subspecies; *nagarum* and *palnica* to *Mus cooki; nitidulus* was synonymised as *M. cervicolor* and raised *M. phillipsi* to a specific rank. The subspecies *gurkha* and *sadhu* of *Mus platythrix* were shifted to *M. saxicola. Mus platythrix* was retained with *bahadur* as a synonym whereas the subspecies *shortridgei* of *Mus platythrix* was raised to a species rank. Marshall further based his keys for identification on mammary formula and length of palatine foramina besides several other characters. Detailed examination of mice collected in the Aravalli ranges reveal that the number of mammae is not a very firm character on which identification keys should be based. One of the females (Oct. 47 Mt. Abu) is over size for *saxicola* (HB = 102 mm, Body wt. 32 g, occipitonasal length 24.5 mm). Its palatine foramina length is more like *platythrix,* but has 4+2 mammae, like *saxicola.* If this specimen was a male (without mammae) we would have straight away put it under *M. platythrix.* Now also it has been assigned to species *platythrix* disregarding the number of mammae and relying on the length of palatine foramina. However, the length of palatine foramina was found to be a firm feature to differentiate between *Mus* species.

We propose the following simple key to identify field mice found in the Aravalli ranges.

A. Tail shorter than head and body

a. Head and body more than 62 mm
1. Palatine foramina elongate, cutting deep between molars .... *Mus saxicola*
2. Palatine foramina short, only touching the first molar
i) Size large, HB more than 95 mm, ON more than 24 mm .... *Mus platythrix*
ii) Size small, HB less than 90 mm, ON less than 23 mm .... *Mus phillipsi*
b. Head and body less than 62 mm Pigmy in size, HB up to 60 mm, ON about 17 mm .... *Mus terricolor*

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CLADOCERAN MALES FROM THE INDIAN REGION[1]

K. Venkataraman[2]

(With fifty-two text-figures)

Key word: Cladocera, males, records

Very few Cladocera males have been reported from India. They are uncommon in nature. This study, describes males of sixteen species from six families of Cladocera, collected in different parts of India including Andaman and Nicobar islands.

Introduction

The routine identification of Cladoceran species is based on characters of mature females such as body size, head shape, nature of postabdomen and head shield. These are variable featured hence, it is important to examine several specimens from a population for identification. Frey (1987) has shown that males are more important in defining the species than the parthenogenetic females, as they are readily recognised by their antennules, which are longer than those of the female and are mobile with well developed setae; these characteristic features are used in species identification. However, males are always rare in populations and their collection is seasonal. Therefore males of most species of Cladocera have often remained unknown. This study describes males of sixteen species of Cladocera belonging to six families occurring in Tamil Nadu (8°-12° N), Rajasthan (27° 7.6'-27° 12.2' N) (Keoladeo National Park, Bharatpur and neighbouring area), Andaman and Nicobar Islands (10° 30'-13° 15' N) and West Bengal (23°-24° N).

Material and Methods

Cladoceran samples were collected throughout Tamil Nadu, certain parts of Rajasthan (Keoladeo National Park, Bharatpur and adjacent areas), Andaman and Nicobar Islands and West Bengal from various types of habitat such as rice fields, marshes, ponds, lakes, reservoirs, streams and rivers. A plankton net of 45 cm diameter was dragged close to the bottom in shallow water, among vegetation and in open water areas. Samples were then immediately fixed and preserved in 5% formalin. A total of 16 species of freshwater Cladocera males were examined (Table 1).

Description

1. **Latonopsis australis** Sars, 1885
(Figs. 1-3)

Material examined: Madurai, Tamil Nadu.

MALE: Body size 0.73 mm. Body oblong. Head short and thick, visually not separated from the body (Fig. 1). Eye large, situated near antero-dorsal end of the head. Ocellus small. Antennules long, attached to antero-ventral corner of head; with a club-shaped series of setae on the proximal end (Fig. 2). Segmentation in antennule not clearly visible. Postabdomen short with two long sperm ducts. Lateral surface armed with a series of 4-5 denticles. Claw pointed and curved dorsally and with 2 long basal spines (Fig. 3). Proximal end of the postabdomen with 2 long natatorial setae.

2. **Diaphanosoma excisum** Sars, 1885.
(Figs. 4-6).

Material examined: Madurai, Tamil Nadu.

MALE: Body size 0.98 mm. Head large and rounded anteriorly. Eye relatively small. Duplicature forming an acute angle with the ventral margin anteriorly; postero-ventral corner broadly rounded with 6-8 marginal denticles followed by a series of fine setules and ending in 2 long spines (Fig. 4).

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[2] Zoological Survey of India, M-Block, New Alipore, Calcutta-700 053.

Table 1
LIST OF CLADOCERA MALES SO FAR RECORDED
(RECORDS ARE GIVEN IN PARENTHESES)

Family Sididae	
Genus	*Latonopsis*
	1. *L. australis* Sars, 1885 (China, Sieh-chih and Nan-shan 1979)
Genus	*Diaphanosoma*
	2. *D. excisum* Sars, 1885 (China, Sieh-chih and Nan-shan 1979)
Family Daphnidae	
Genus	*Daphnia*
	3. *D. similis* Claus, 1876
	4. *D. cephalata* King, 1852 (Australia, Hebert 1977; India, Venkatarman 1991)
	5. *D. projecta* Hebert, 1977 (India, Venkataraman and Krishnaswamy 1984)
Family Moinidae	
Genus	*Moina*
	6. *M. micrura* Kurz, 1874 (India, Venkataraman 1983, Michael and Sharma 1989; USA, Goulden 1984)
	7. *M. weismanni* Ishikawa, 1896 (India, Venkataraman and Krishnaswamy 1984)
Genus	*Moinodaphnia*
	8. *M. macleayii* (King, 1853) (Africa, Goulden 1968)
Family Macrothricidae	
Genus	*Macrothrix*
	9. *M. spinosa* King, 1852
Family Chydoridae	
Genus	*Alona*
	10. *Alona davidi punctata* Richard, 1895
	11. *A. pulchella* King, 1853 (Malaysia, Idris 1983)
Genus	*Biapertura*
	12. *B. karua* King, 1853 (India, Venkataraman 1983, Michael and Sharma 1989; China, Sieh-chih and Nan-shan 1979)
	13. *B. verrucosa* Sars, 1901 (China, Sieh-chih and Nan-shan 1979)
Genus	*Kurzia*
	14. *K. longirostris* (Daday, 1989) (Africa, Smirnov 1977)
Genus	*Leydigia*
	15. *L. ciliata* Gauthier, 1939 (Australia, Smirnov 1977)
Family Bosminidae	
Genus	*Bosminopsis*
	16. *B. deitersi* Richard, 1895 (China, Sieh-chih and Nan-shan 1979)

Antennules long and attached to the postero-ventral part of head, with a group of short setae attached at 1/5 of its length with a row of fine setules decreasing in size up to the tip (Fig. 5). Postabdomen with 2 long sperm ducts. Claw with a series of spinules increasing in size proximally and with 3 long, sharply pointed basal spines (Fig. 6).

3. **Daphnia similis** Claus, 1876

(Figs. 7-10)

Material examined: Madurai, Tamil Nadu; Bharatpur, Rajasthan.

MALE: Body size 1.38 mm. Carapace oblong. Tail short. Head small, rostrum undeveloped (Fig. 7). Antennules long with well developed flagellum (Fig. 8). Eye large, ocellus conspicuous. Abdominal processes greatly reduced. Dorsal postabdominal margin strongly sinuate, with 6-8 anal spines (Fig. 9). Anterior margin of the valve with setae. Leg I modified as a hook with a long flagellum (Fig. 10).

4. **Daphnia cephalata** King, 1852

(Figs. 11-14)

Material examined: Madurai and Tirunelveli, Tamil Nadu.

MALE: Body size 1.08 mm. Head large and

rounded (Fig. 11). Anterior margin of valve with fine setules up to 1/3 of the ventral margin. Antennules long with well developed flagellum. Terminal seta short, distally plumose. Basopodite with no rows of spinules (Fig. 12). Leg I with a hook and a long seta (Fig. 13). Postabdomen with no dorsal process. Claw slightly curved, 11-14 anal spines, relatively short, robust and subequal. Dorsal margin flat (Fig. 14).

5. **Daphnia projecta** Hebert, 1977
(Figs. 15-17)

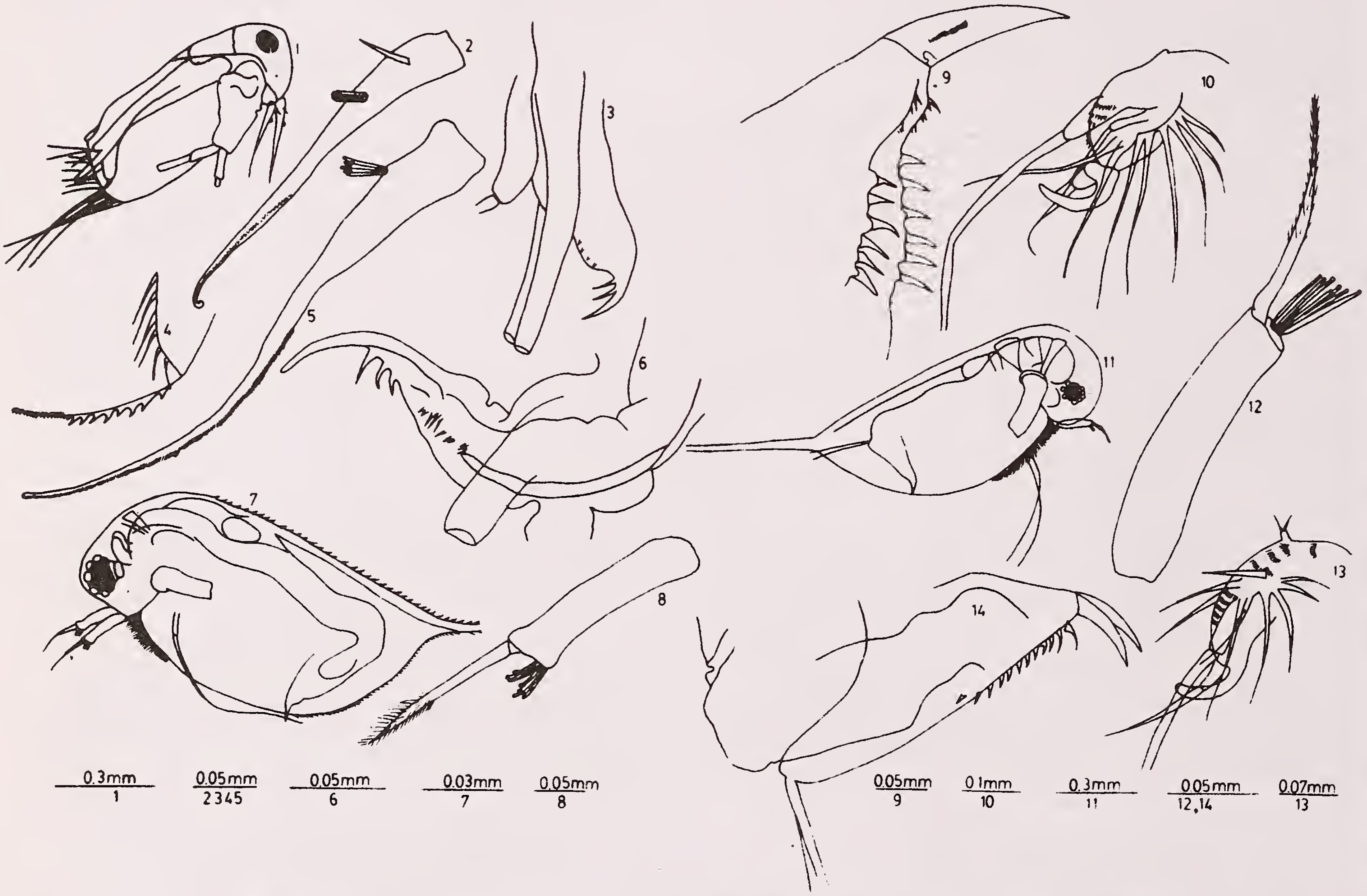
Material examined: Madurai, Tamil Nadu.

MALE: Body size 0.9 mm. Head large with anteriorly projecting helmet; rostrum absent; dorsal margin of head and body straight with spines (Fig. 15). Antennules well developed and movable; flagellum in the antennules not well developed (Fig. 16). Eye moderately large, ocellus inconspicuous. Ventral margin convex. Tail long. The first pair of legs modified to form a prehensile organ which terminate in a long seta protruding beyond the shell to the exterior. Total size smaller than female. Postabdominal process not present; dorsal margin with 10-12 anal spines (Fig. 17).

6. **Moina micrura** Kurz, 1874
(Figs. 18-21)

Material examined: Madurai, Tamil Nadu.

MALE: Body size 0.62 mm. Body oblong; head narrow and extended anteriorly (Fig. 18). Well developed supraocular depression. Eye large. Antennules long and bent at 1/3 the distance from the head, with three hooks at the tip. Two sensory setae, one short and another originating at the knee



Figs. 1-3: *Latonopsis australis* Sars: (1) male (entire); (2) antennule; (3) postabdomen.
Figs. 4-6: *Diaphanosoma excisum* Sars: (4) postero-ventral corner; (5) antennule; (6) postabdomen.
Figs. 7-10: *Daphnia similis* Claus: (7) male (entire); (8) antennule; (9) postabdomen; (10) leg I.
Figs. 11-14: *Daphnia cephalata* King: (11) male (entire); (12) antennule; (13) leg I; (14) postabdomen.

of the bend (Fig. 19). First leg with a well developed hook extended at right angles to the leg (Fig. 20). Postabdomen similar to female with setae on claw, a pair of feathered teeth on the dorsal side (Fig. 21).

7. **Moina weismanni** Ishikawa (1896)

(Figs. 22-25)

Material examined: Madurai, Tamil nadu.

MALE: Body size 0.7 mm. Body oblong. Supraocular depression distinct (Fig. 22). Antennule bent at a point about 1/4 the distance from the head with four hooks at the tip (Fig. 23). Leg I with a weakly developed hook (Fig. 24). Postabdomen similar to that of female with varying number of feathered teeth (Fig. 25).

8. **Moinodaphnia macleayii** (King, 1853)

(Figs. 26-29)

Material examined: Wandoor, Port Blair, Andaman and Nicobar Islands.

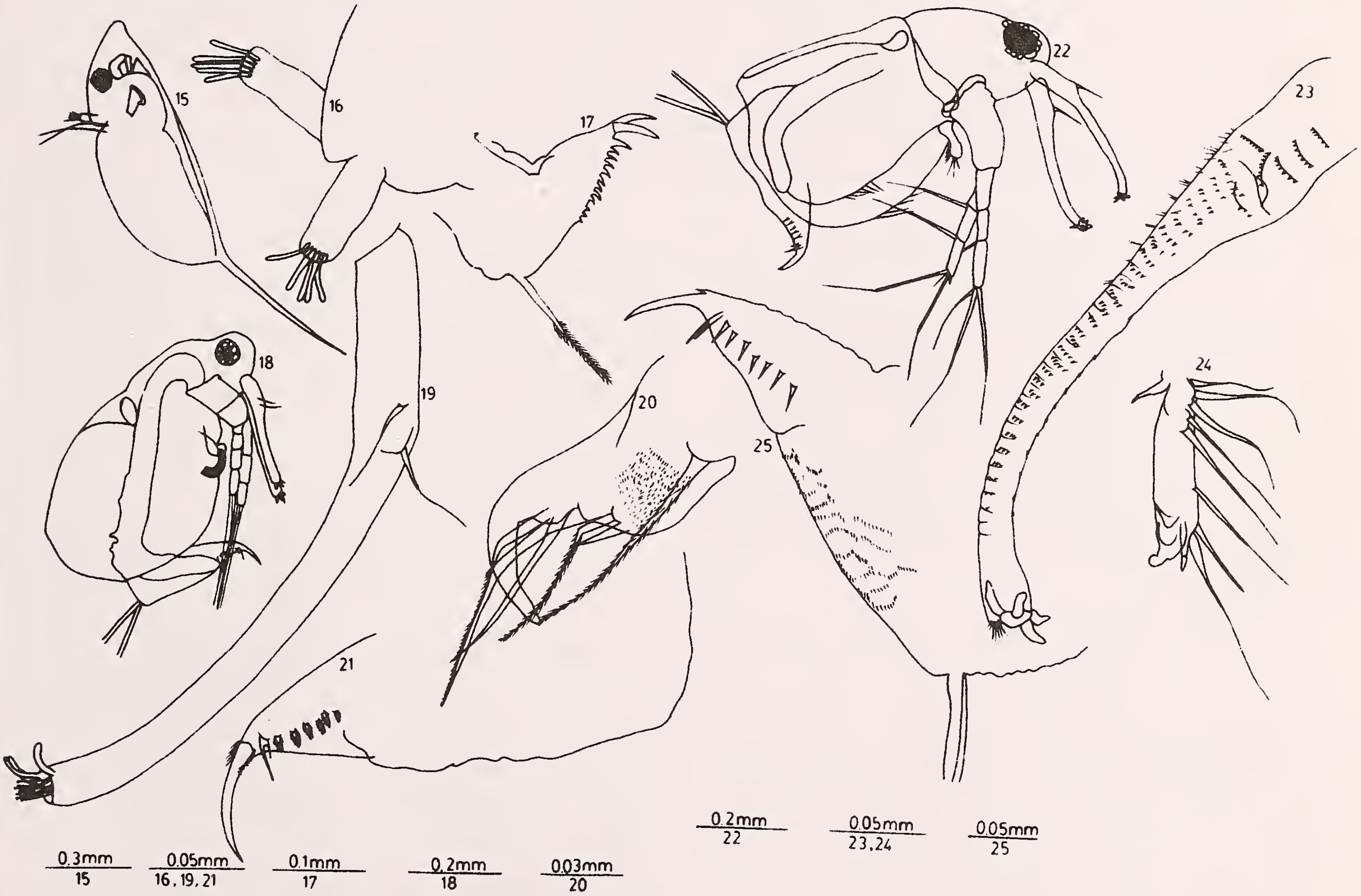
MALE: Body size 0.76 mm. Head elongated with a large eye (Fig. 26). Ocellus present. Antennules long and curved with sensory papillae at the distal tip (Fig. 27). First leg with a large curved hook (Fig. 28). Postabdomen similar to that of female with 6-7 feathered teeth (Fig. 29).

9. **Macrothrix spinosa** King, 1852

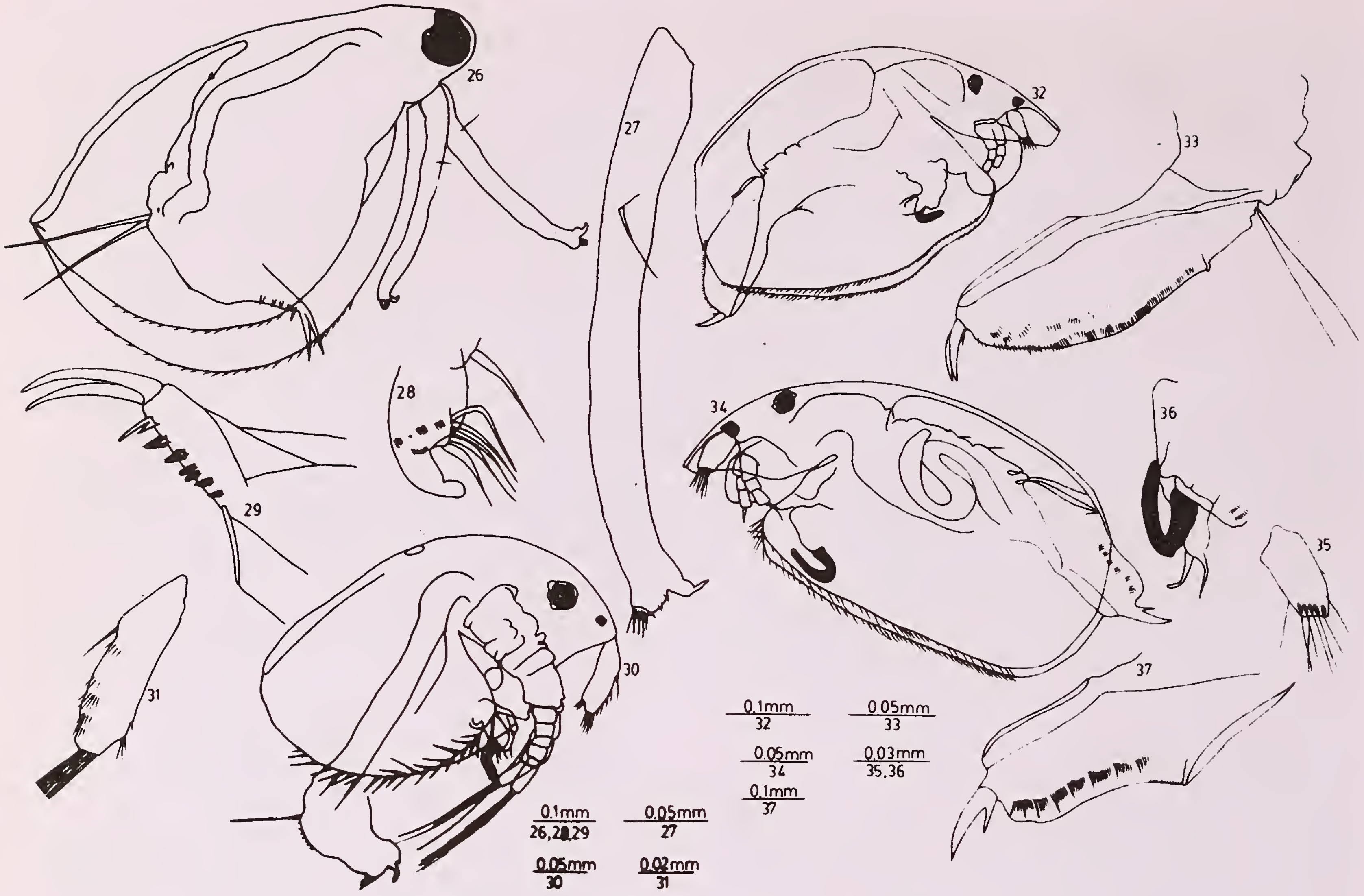
(Figs. 30-31)

Material examined: Bharatpur, Rajasthan; Madurai, Tamil Nadu.

MALE: Body size 0.33 mm. Carapace rounded-oval, with scale-like patterns; posterior margin blunt, ventral margin broadly rounded, serrated and with a series of long setae (Fig. 30). Antennules short with a long seta near the base and a series of spinules arranged transversely on entire surface and a group



Figs. 15-17: *Daphnia projecta* Hebert: (15) male (entire); (16) antennule; (17) postabdomen.
Figs. 18-21: *Moina micrura* Kurz: (18) male (entire); (19) antennule; (20) leg I; (21) postabdomen.
Figs. 22-25: *Moina weismanni* Ishikawa: (22) male (entire); (23) antennule; (24) leg I; (25) postabdomen.



Figs. 26-29: *Moinodaphnia macleayii* King: (26) male (entire); (27) antennule; (28) leg 1; (29) postabdomen.
Figs. 30-31: *Macrothrix spinosa* King: (30) male (entire); (31) antennule.
Figs. 32-33: *Alona davidi punctata* Richard: (32) male (entire); (33) postabdomen.
Figs. 34-37: *Alona pulchella* King: (34) male (entire); (35) antennule; (36) leg 1; (37) postabdomen.

of sensory setae on the apex (Fig. 31). Postabdomen broadly rounded with indistinctly concave anal margin. Claw short, curved dorsally and serrated on the surface. As in the female, dorsal distal corner rounded, armed with a group of strong, sharply pointed denticles.

10. **Alona davidi punctata** Richard, 1895

(Figs. 32-33)

Material examined: Madurai, Tamil Nadu.

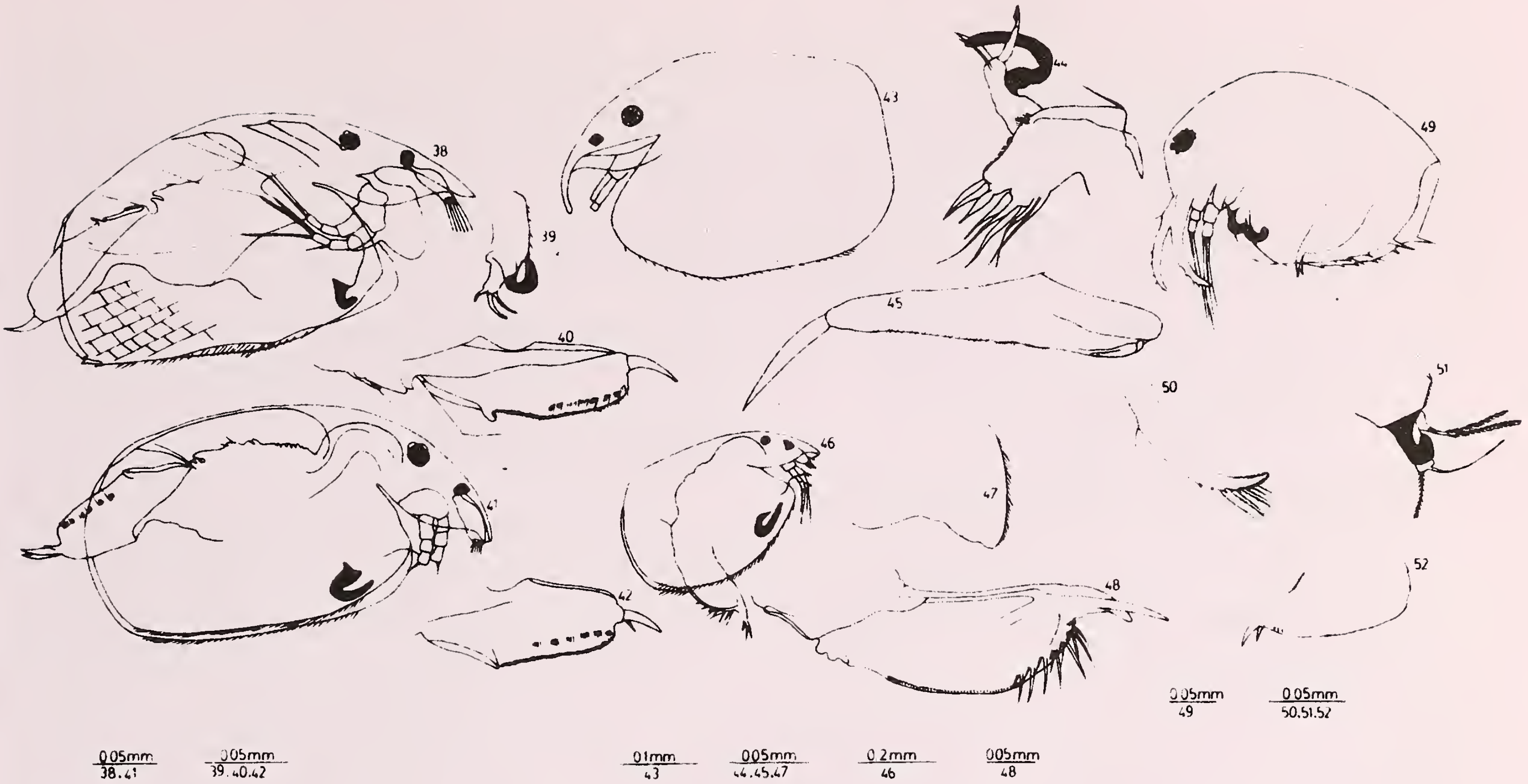
MALE: Body size 0.42 mm. Dorsal part of the body highly arched and moon shaped. Postero-ventral and postero-dorsal corners rounded. Ventral margin projecting in the middle (Fig. 32). Rostrum blunt. Antennules not reaching the apex of rostrum. Plate of labrum rounded anteriorly, evenly curved posteriorly. Postabdomen widest at middle, then tapering distally with prominent preanal and postanal corners. Claw with very short basal spine. Sperm duct open at the ventral side at the base of the claw (Fig. 33).

11. **Alona pulchella** King, 1853

(Figs. 34-37)

Material examined: Madurai, Tamil Nadu.

MALE: Body size 0.33 mm. Dorsal and ventral margins of valves almost parallel. Postero-dorsal and postero-ventral corner of valves rounded (Fig. 34). Ocellus smaller than eye, situated half way between the eye and the apex of rostrum. Antennules stout and broad with two setae at dorsal and ventral side (Fig. 35). Labral plate about the same as in female, first leg with a copulatory hook (Fig. 36). Postabdomen short, dorsal margin of postabdomen



Figs. 38-40: *Biapertura karua* King: (38) male (entire); (39) leg I; (40) postabdomen.
Figs. 41-42: *Biapertura verrucosa* Sars: (41) male (entire); (42) postabdomen.
Figs. 43-45: *Kurzia longirostris* (Daday): (43) male (entire); (44) leg I; (45) postabdomen.
Figs. 46-48: *Leydigia ciliata* Gauthier: (46) male (entire); (47) labrum; (48) postabdomen.
Figs. 49-52: *Bosminopsis deitersi* Richard: (49) male (entire); (50) antennule; (51) leg I; (52) postabdomen.

without denticles, lateral side with 8 groups of setae, the distalmost seta being the longest of each group and slightly projecting beyond the dorsal margin. Anal margin with spines. Claw short with a short basal spine (Fig. 37).

12. **Biapertura karua** King, 1853
(Figs. 38-40)

Material examined: Madurai, Tamil nadu.

MALE: Body size 0.31 mm. Maximum height of body slightly before middle. Valves with distinct lines and polygonal patterns (Fig. 38). Postero-ventral corner rounded with 2 to 3 denticles attached marginally. Ocellus smaller than eye, situated closer to the eye. Plate of labrum rounded anteriorly, slightly pointed ventrally with or without a notch on the apex. Leg I modified into a hook (Fig. 39). Postabdomen with distinct preanal and postanal corners with rounded dorsal-distal margin. About 8 groups of denticles attached submarginally at the lateral side. Claw with or without basal spine (Fig. 40).

13. **Biapertura verrucosa** Sars, 1901
(Figs. 41-42)

Material examined: Madurai, Tamil Nadu.

MALE: Body size 0.29 mm. Postero-dorsal and postero-ventral corner of the valve rounded (Fig. 41). Rostrum blunt, antennules long, almost reaching apex of rostrum. Ocellus smaller than eye. Plate of labrum rounded with a denticle on the anterior margin. Postabdomen with distinct preanal and postanal corners and rounded on dorsal-distal corner. A series of small spines attached along the dorsal margin. Lateral side of postabdomen with 6 to 7 groups of setae, the distalmost seta being the longest of each group and projecting beyond the anal margin (Fig. 42). Claw with relatively short basal spine.

14. **Kurzia longirostris** (Daday, 1898)
(Figs. 43-45)

Material examined: Madurai, Tamil Nadu.

MALE: Body size 0.42 mm. Body evenly

rounded dorsally and convex posteriorly, maximum height before middle (Fig. 43). Rostrum long and pointed ventrally. Ocellus smaller than eye, twice nearer to the eye than to the apex of rostrum. Leg I modified into a hook (Fig. 44). Postabdomen long, tapering distally. Dorsal surface with relatively small spines submarginally. Claw rather long, curved, without basal spine (Fig. 45).

15. **Leydigia ciliata** Gauthier, 1939
(Figs. 46-48)

Material examined: Madurai, Tamil Nadu.

MALE: Body size 0.53 mm. Postero-dorsal corner of valve at level of maximum height. Postero-ventral corner rounded (Fig. 46). Ocellus larger than eye. Antennules not reaching apex of rostrum. Plate of labrum with pubescent anterior margin (Fig. 47). Postabdomen widest in the middle, distal corner rounded; lateral groups each with 3 setae, distal seta longest in each group, proximal seta shortest. Claws without basal spine. Vas deferens opening on apex of penis-like process (Fig. 48).

16. **Bosminopsis deitersi** Richard, 1895
(Figs. 49-52)

Material examined: Ganga River, Barrackpore, West Bengal.

MALE: Body size 0.29 mm. Body oval in shape. Postero-dorsal corner distinct, postero-ventral corner with spines (Fig. 49). Head large with a long rostrum. Antennules long, with about 5-6 sensory setae near the apex (Fig. 50). Eye large. Valves with faint polygonal reticulations. Leg I with a hook (Fig. 51). Postabdomen small, tapering distally with small spines on the dorsal side. Claw with a large serrated basal spine (Fig. 52).

DISCUSSION

Among the 93 species of Cladocera recorded from India (Michael and Sharma 1988), only 13 males have been described so far. Likewise, out of 62 species of Cladocera collected from Malaysia (Idris 1983), only 2 males have been found. Sieh-chih and Nan-Shan (1979) described 136 species of Cladocera from China and described 48 males. Swar and Fernando (1979) described 23 species of Cladocera from Nepal without a single representation of male. There are thus several examples to show that the males of Cladocera are rare. From the present study it appears that in tropical and subtropical latitudes of India, males usually appear for a very short period and sometimes in small numbers, so that most collections do not contain males unless special efforts are made. Chengalath (1982) also found the same phenomenon of rarity of males in the case of temperate cladocerans.

The causes of production of males at a particular time of the season are not fully understood. Some of the possible reasons are temperature, food and overcrowding (Pennak 1978). The number of pre-reproductive instars of males vary from species to species. Life history studies on the males have been worked out for a few species only. Das *et al.* (1981) have studied the life history of males of *D. lumholtzi.* Likewise, Venkataraman (1990a, b) studied the life history of males of *D. similis, D. cephalata* and *Moina weismanni.* From these studies it has been found that adult males are not similar to adult females; however, juvenile males have some similarity to the females. Adult males tend to be more highly differentiated than the females, particularly in the structure of the antennule as in the case of Sididae, Daphnidae and postabdominal claws as in Chydoridae, so that males are sometimes essential in determining the identity of the species. Another important character that diferentiates males from females is the presence of a hook in the first trunk limb. This often helps the male to hold the female during mating. The male postabdomen bears a pair of vas deferens which protrude like a long tube in Sididae and Chydoridae, and it also appears as two openings at the base of the claw in other families.

ACKNOWLEDGEMENTS

I thank the Director, ZSI, Calcutta, Dr. V.S. Vijayan, B.N.H.S., Bharatpur, Dr. G.C. Rao, Officer-in-Charge, Z.S.I., Andaman and Nicobar Regional Station and Dr. S.K. Tandon, Joint Director, Calcutta for facilities provided to carry out this work.

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NEW DESCRIPTIONS

DESCRIPTION OF A NEW GENUS OF ECTRICHODIINAE AND TWO NEW SPECIES OF THE GENUS *HAEMATORRHOPHUS* STAL FROM SOUTHERN INDIA (HETEROPTERA: REDUVIIDAE)[1]

C. Murugan and David Livingstone[2]

(*With three text-figures*)

A new reduviid genus *Hemihaematorrhophus* gen. nov. with the type species *Hemihaematorrhophus planidorsatus* sp.nov. and two new species of the genus *Haematorrhophus*, namely *Haematorrhophus fovealis* sp.nov. and *Haematorrhophus ruguloscutellaris* sp.nov. have been described and illustrated.

Introduction

The subfamily Ectrichodiinae is one of the larger subfamilies of Reduviidae. Distant (1904, 1910) while describing the various genera of the subfamily Ectrichodiinae, considered the number of joints of antennae as a primary character for the diagnosis of the various genera and on that basis four to eight joints have been recognised in the various genera of Ectrichodiinae. Later, Cook (1977), while preparing the checklist of the various genera and species of Asian Ectrichodiinae, considered the rostrum as an important character for diagnosis. The genus *Haematorrhophus* has been described by Distant as having six segmented antennae, abdomen and connexivum wrinkled in various patterns and the second and third rostral segments highly swollen. The present genus is placed closer to *Haematorrhophus*.

Since the cataloguing of the genera of this subfamily by Cook (1977) three more genera, namely *Synectrychotes* Livingstone and Murugan (1987), *Neohaematorrhophus* Ambrose and Livingstone (1986), *Echinocoris* Livingstone and Ravichandran (1992) have been added. The genus *Haematorrhophus* has the largest number of described species among Ectrichodiinae and the two species that are described below further add to the Reduviid fauna of the Oriental Region.

Hemihaematorrhophus gen. nov.

Micropterous; violaceous black; antennae six segmented; second rostral segment not incrassated and almost as long as first segment; frontal striations prominent on either side, clypeal carina prominent; scutellum with a pair of nodule like tubercles kept wide apart; the first abdominal segment with median dorsal depression; on either side of the depression smooth; abdomen smooth dorsally with very few faint longitudinal marginal striations; mesosternal tubercle not carinate and not acutely pointed.

It differs from *Haematorrhophus* by the second rostral segment only obscurely incrassated; the abdomen dorsally more or less smooth; and the femoral tubercles not conspicuous.

Hemihaematorrhophus planidorsatus sp.nov.
(Fig. 1)

FEMALE: Length 24-28 mm, width across the abdomen 10-12 mm; violaceous black; elongately ovate; micropterous; frontal striations prominent on either side, clypeal carina prominent; eyes fuscous; second rostral segment not incrassated and almost as long as first segment; the mesosternal furrow shallow posteriorly, anteriorly narrow as a short striated groove, immediately behind this narrow groove the sternal tubercle heaves up prominently; abdominal sternites without any longitudinal furrow, first visible sternites elevated medially with lateral depression; pronotal median furrow transversely divided at the junction as well as behind the junction

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[1] Accepted July 1995.

[2] Department of Zoology, Madras Christian College, Tambaram, Madras-600 059, Tamil Nadu, India.

of anterior and posterior lobes, posterior lobe with two transverse ridges; the inner lateral foveation not confluent with the depression of the posterior lobe, but the lateral deeply depressed groove confluent with the depression of the posterior lobe; scutellum with a pair of nodule like tubercles kept wide apart; the median dorsal foveation not interrupted by ridges; mesonotum not visible; the first four abdominal segments with median dorsal depression; on either side of the depression smooth; abdomen smooth dorsally with very few faint longitudinal marginal striations; connexivum dorsally rugulose, posterior most segment entirely dorsally rugulose; fore femora with one prominent and very minute two or three tubercles in the middle, mid femora with a pair of two short tubercles subapically and basally a single one, hind femora with a pair of very minute subapical tubercles.

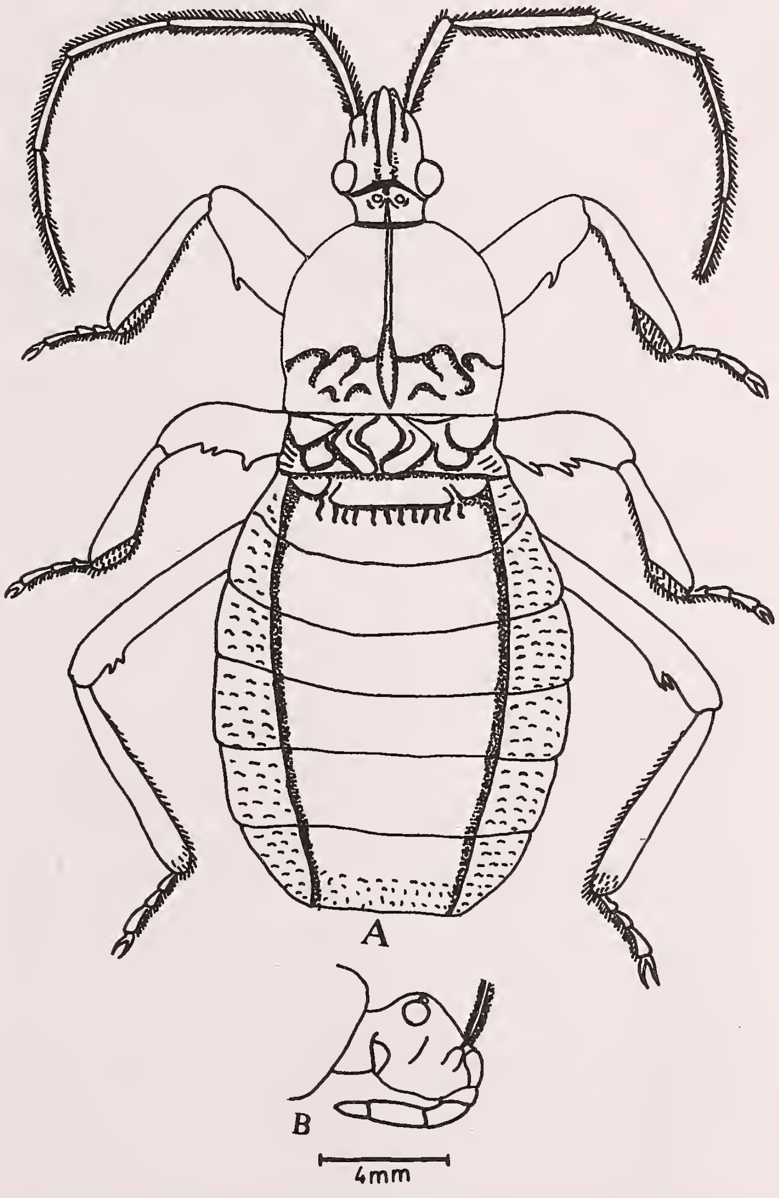

Fig. 1. A. *Hemihaematorrhophus planidorsatus* sp. nov.; B. Head-Lateral view.

Scutellar variations range from obscure knob like lateral tubercle to fairly well formed tuberculate process.

Type Information: *Holotype*: FEMALE, Serial No. 52. *Paratypes* three females all pinned specimens deposited for the present in the reduviid collection of the Division of Entomology, Department of Zoology, Madras Christian College, Tambaram, Madras, India.

Collection Information: *Holotype* collected from underneath stone in Servalar Tropical Rain Forest, Tirunelveli District, Tamil Nadu on 14-10-1987 at elevation 300 MSL, temperature 35° C, and humidity 74%. The *Paratypes* were collected from Yelagiri Hills, North Arcot District, Tamil Nadu, on 18.9.1988 at elevation 1000 MSL, temperature 28°C and humidity 76% and from Alagar Kovil, Madurai District, Tamil Nadu on 18-01-1989 at elevation 350 MSL, temperature 27°C and humidity 84% and also collected from Courtallam, Tirunelveli District, Tamil Nadu on 06.6.1989 at elevation 350 MSL, temperature 28°C and humidity 62%. Since all specimens collected on all occasions are from Tropical Rain Forest only, it is reasonable to suggest that this is a species endemic to that ecosystem of this region.

Haematorrhophus fovealis sp.nov.
(Fig. 2)

MALE: Length 25 mm, width across the abdomen 9.5 mm; apterous; black; elongate; median frontal groove shallow, parafrontal transverse striations obscure; eyes yellowish brown; mesosternal foveation shallow and transversely striated, posteriorly forming prominent tubercle, the first visible abdominal sternite without any longitudinal grooves whereas the next three sternites with incomplete longitudinal groove; the tubercle of fore femora outwardly directed, not highly incrassated; the mid femora with a subapical anterior pair and a middle unpaired small tubercles; hind femora with a small median tubercle and a pair of small subapical tubercles one on either side; the scutellum generally globose, with acutely pointed tubercles and deeply grooved in between, median foveation of scutellum deep with slightly rugose wall, lateral wall of scutellum basally rugose with raised rounded inner margin; mesonotum not exposed; pronotal median furrow interrupted by a ridge, lateral inner foveation, outer foveation and its groove and posterolateral depression almost confluent with each other with transverse striations along the groove; dorsum highly rugose with dorso median depression, broader anteriorly and narrow posteriorly up to the fifth segment, depression not confluent with each other.

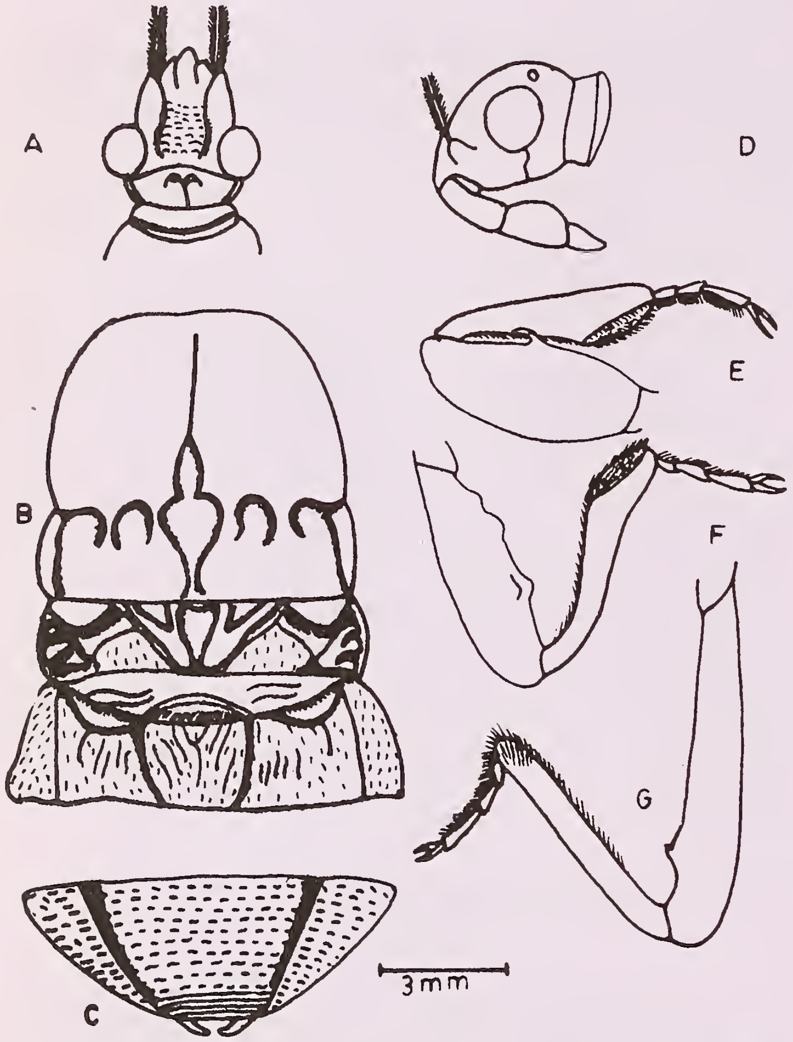

Fig. 2. *Haematorrhophus fovealis* sp. nov.: A. Head-Dorsal view; B. Thorax and anterior abdominal segments; C. Genital segments; D. Head — Lateral view; E. Fore leg; F. Mid leg; G. Hind leg.

Type Information: *Holotype*: Male, Serial No. 50, pinned specimen deposited at present in the reduviid collection of the Division of Entomology, Department of Zoology, Madras Christian College, Tambaram, Madras, India.

Collection Information: Single specimen collected from underneath stone in Malumichampatti, Coimbatore District, Tamil Nadu, on 01.8.1989 at elevation 300 MSL, temperature 25° C, and humidity 82%.

Haematorrhophus ruguloscutellaris sp.nov.

(Fig. 3)

FEMALE: Length 23 mm, width across the abdomen 8 mm; elongate; apterous; black; median frontal groove deep, parafrontal cross striations prominent, eyes yellowish brown; mesosternal foveation anteriorly narrow and cross striated, posteriorly the furrow terminating at the base of the median pointed conical tubercle with a median carina; metasternum obscure; fore femora median tubercle posteriorly directed; mid femora with two or three small tubercles; femora subapically with a pair of small tubercles; abdominal sternites without any median

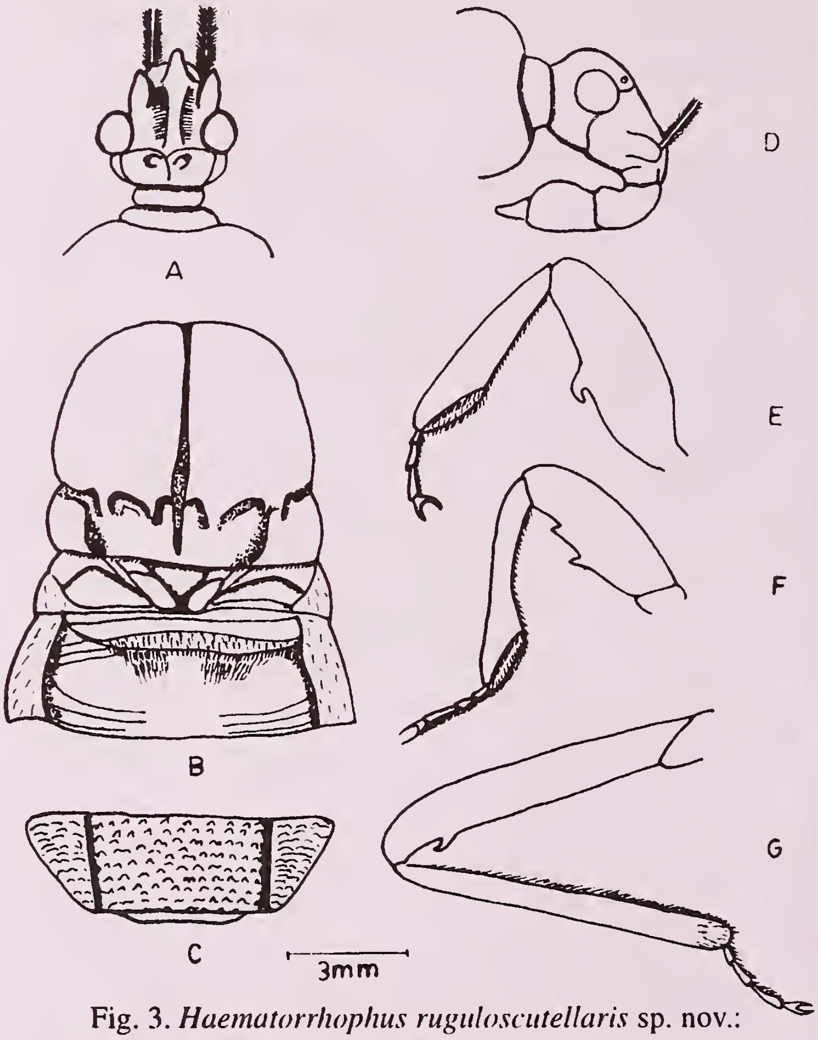

Fig. 3. *Haematorrhophus ruguloscutellaris* sp. nov.: A. Head — Dorsal view; B. Thorax and anterior abdominal segments; C. Genital segments; D. Head — Lateral view; E. Fore leg; F. Mid leg; G. Hind leg.

groove, the first visible abdominal sternite medially elevated by lateral depression; scutellar tubercles obscurely formed, as nodules, set wide apart; lateral margins of scutellum corrugated, median dorsal foveation smooth and narrow; mesonotum not exposed; pronotal median foveation confluent with the posterior one; lateral inner foveation not confluent with any outer foveation cum groove, confluent with posterolateral depression of posterior lobe of pronotum; dorsum of fourth abdominal segment longitudinally rugose, all the rest of the segments transversely rugose; all connexival segments rugose.

Type Information: *Holotype* FEMALE, Serial No. 51. *Paratype* a single male, both pinned specimens deposited at present in the reduviid collection of the Division of Entomology, Department of zoology, Madras Christian College, Tambaram, Madras, India.

Collection Information: *Holotype* and *Paratype* were collected from underneath a boulder in Manimutharu, Tirunelveli District, Tamil Nadu, on 10.01.1988, at elevation 75 MSL, temperature 29°C and humidity 58%.

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HYPSELOBARBUS KURALI (PISCES: CYPRINIDAE) A NEW LARGE BARB FROM THE SOUTH WESTERN RIVERS OF PENINSULAR INDIA[1]

A.G.K. MENON AND K. REMA DEVI[2]

(*With a text-figure*)

Hypselobarbus kurali is described as a new species of large barbs from the South-Western rivers of Peninsular India. It is characterised by 4 barbels, a weak articulated last undivided ray with nine branched rays in the dorsal fin, 41-43 scales along the lateral line, 3½-4½ rows of scales between Ll and pelvic origin; silvery with somewhat greyish back, a deep black bar behind the gill opening and the caudal tipped black. The identity of two cyprinid species, *Cyprinus curmuca* Hamilton and *Barbus kolus* Sykes from the east flowing rivers of the Peninsula considered as distinct species is re-examined. *B. kolus* is considered a synonym of *H. curmuca.*

INTRODUCTION

Hamilton (1807) described *Barbus curmuca* from Vedawati river of the Tungabhadra drainage in Mysore, with two barbels, 39 scale rows along the lateral line and a weak and articulated last undivided dorsal ray. Sykes in 1840 described *B. kolus,* also with the same characteristics from Deccan. Specimens from South Canara with four barbels and the caudal tipped with black, Day (1878) considered as a local variety of *B. curmuca.* In a recent fish collection made by the senior author from different

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[1] Accepted March 1995.

[2] Zoological Survey of India, Southern Regional Station, 100, Santhome High Road, Madras-400 028.

TABLE 1

MORPHOMETRIC DATA OF *HYPSELOBARBUS KURALI* FROM DAKSHIN KANNADA AND KERALA

	Dakshin Kannada with tail tipped black n = 14				Kerala							
					with tail tipped black n = 19				with plain caudal tips n = 14			
Standard length (mm)	120.0-270.0				78.0-175.0				94.0-196.0			
	in SL		in HL		in SL		in HL		in SL		in HL	
	Range	x̄	Range	x̄	Range	x̄	Range	x̄	Range	x̄	Range	x̄
Head length	3.37-3.80	3.49			3.31-3.81	3.63			3.23-3.82	3.56		
Body depth	3.28-4.00	3.69			3.64-4.39	4.08			3.76-4.83	4.35		
Predorsal length	1.91-2.25	2.03			2.02-2.16	2.09			2.05-2.56	2.20		
Postdorsal length	1.67-2.10	1.85			1.74-1.97	1.86			1.78-1.99	1.90		
Length of dorsal fin	3.64-4.80	4.24	1.06-1.38	1.22	4.23-5.17	4.57	1.14-1.36	1.26	4.22-5.27	4.71	1.24-1.41	1.32
Length of pectoral fin	4.22-5.00	4.60	1.23-1.45	1.32	4.84-5.57	5.15	1.27-1.63	1.42	4.34-5.10	4.78	1.20-1.47	1.35
Length of pelvic fin	5.28-6.22	5.66			5.26-6.12	5.73			5.11-6.24	5.70		
Length of anal fin	3.65-6.00	4.60			4.81-6.32	5.69			4.11-6.37	5.24		
Length of caudal fin	2.79-4.55	3.44			2.93-3.89	3.36			3.13-4.45	3.57		
Distance between pectoral to pelvic origin	3.33-4.02	3.75			3.54-4.40	3.89			3.30-4.29	3.83		
Distance between pelvic to anal origin	3.40-4.21	3.85			3.44-4.31	3.89			3.63-4.54	3.94		
Length of body cavity	1.89-2.18	2.02			1.90-2.33	2.07			1.88-2.24	2.06		
Depth of head			1.44-1.68	1.54			1.40-1.59	1.48			1.46-1.71	1.58
Maximum head width			1.60-2.00	1.85			1.56-1.96	1.76			1.74-2.04	1.87
Eye diameter			4.00-5.71	4.72			3.10-5.36	4.13			3.47-5.17	4.40
Snout length			1.97-2.33	2.12			2.03-2.58	2.34			2.11-2.54	2.37
Interorbital width			2.42-2.94	2.67			2.53-3.27	2.85			2.78-3.39	3.17
Length of caudal peduncle/ Depth of caudal peduncle	1.13-1.82	1.36			1.46-1.8	1.63			1.37-1.92	1.62		
Height of dorsal/ Base of dorsal	1.36-1.74	1.54			1.24-1.60	1.38			1.27-1.53	1.40		
Height of anal/ Base of anal	1.82-2.65	2.56			1.76-2.14	1.91			1.59-2.69	2.07		
Predorsal distance/ Postdorsal	0.83-1.03	0.91			0.85-0.97	0.89			0.73-0.93	0.86		

western rivers of the south western part of Peninsular India, there are a good number of specimens of the present unique species which were earlier referred to as *B. curmuca* by Hora and Law (1941). These, with four barbels, a weak last undivided dorsal ray and 41-43 lateral line scales are described here as a new species of *Hypselobarbus*. Rainboth (1989) discussed the nomenclature problem with regard to the poorly known genus of large barbs of Peninsular India and showed the availability of the name *Hypselobarbus* Bleeker, 1860 for them. *H. curmuca* (Ham.), *H. dobsoni* (Day), *H. dubius* (Day), *H. jerdoni* (Day), *H. lithopidos* (Day), *H. micropogon* (C.V.), *H. periyarensis* (Raj), *H. pulchellus* (Day), *H. thomassi* (Day) are included in this genus. *H. kolus* is considered in this paper as a synonym of *H. curmuca.*

MATERIAL AND METHODS

Material examined in this study are: 33 exs., 78.0-270.0 mm SL, with black caudal tips from Dakshin Kannada and Kerala, and 14 exs., 94.0-196.0 mm SL, with plain caudal tips from Kerala. Measurements follow standard practices except a few as followed in Menon and Rema Devi (1992). Description of the new species is based on the pooled average of all the samples from Dakshin Kannada and Kerala, measured and presented in Table 1. The mean followed by the range in parenthesis is provided.

Hypselobarbus kurali sp. nov.

(Fig. 1)

Barbus curmuca Day (nec. Ham.), Fish. India, 577, pl. 141, fig. 1. 1878.

Barbus (Puntius) curmuca (nec. Ham.) Hora and Law, Rec. Indian Mus. 63 (2): 245, 1941 (Travancore). Silas, J. Bombay nat. Hist. Soc. 49: 674, 1951 (Ponneri drainage system, Anamalai Hills). Silas, J. Bombay nat. Hist. Soc. 50: 326. 1951 (Manimala river, Mundakayam, Peerumed Hills).

Puntius curmuca (nec. Ham.) Misra, Rec. Indian Mus. 57: 153. 1959 (Travancore-Cochin).

Holotype: 270.0 mm SL, Locality: Kumaradhara, near Nettana, Dakshin Kannada, Coll.: Drs. A.G.K. Menon, K.B. Jagadeesh and R. Kannan, 7th January 1992, Reg. No. F. 4003.

Paratypes: A. *With black caudal tips from Dakshin Kannada* - 5 exs., 165.0-240.0 mm SL, Kumaradhara river, Behinilae, near Nettana, 7th Jan. 1992. F/ 4004; 6 exs., 120.0-185.0 mm SL, River Netravadi, near Uppinangudi, 30th Dec. 1991, F. 4005.

B. *With black caudal tips from Kerala* - 2 exs., 81.0-120.0 mm SL, River Achencoil, Quilon District, 6th Nov. 1989; 3 exs., 106.0-175.0 mm SL, Kallar river, near Pullikkayam, 7th Nov. 1989, F. 4006; 5 exs., 112.0-148.0 mm SL, Periyar River at

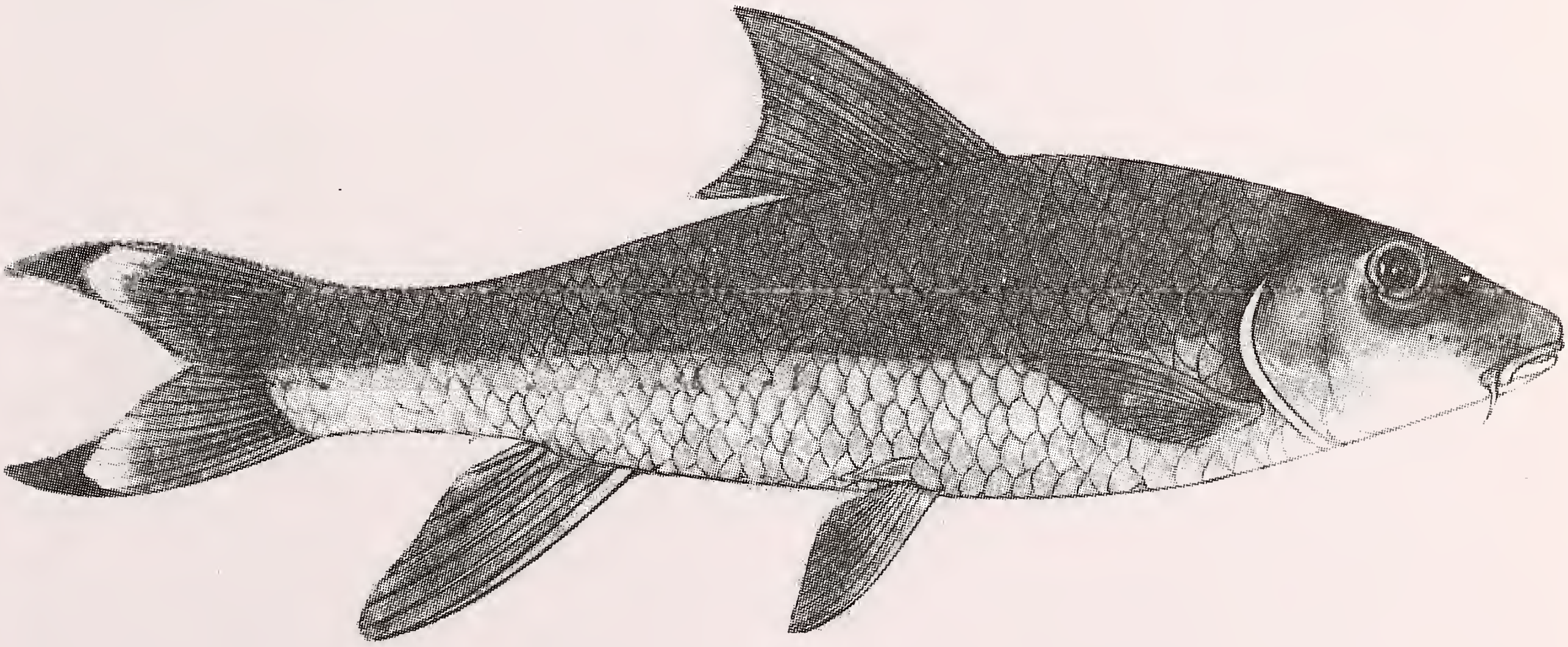

Fig. 1. Lateral view of *Hypselobarbus kurali* sp. nov., 240.0 mm SL.

Neriyamangalam, Iddukki District, 3rd Oct. 1990, F. 4007; 9 exs., 78.0-143.0 mm SL, Manimala river at Mundakayam, 12th Sept, 1991.

C. *With plain caudal tips from Kerala* - 2 exs., 94.0-101.0 mm SL, Periyar river at Thannikudy, 14 km east of Thekkady, Periyar Tiger Reserve, 13th Dec. 1990, F. 4008; 4 exs., 165.0-190.0 mm SL. Iddukki reservoir, 28th Sept. 1990, F. 4009; 4 exs., 151.0-196.0 mm SL, Cherukotta Oda, a tributary of Periyar River at Cheruthony, Periyar Tiger Reserve, Thekkady, 13th Dec. 1990, F. 4010 and 4 exs., 112.0-145.0 mm SL, Periyar River at Mleppara, 12 km east of Thannikudy Forest Inspection Bungalow, Periyar Tiger Reserve, 14th December, 1990, F. 4011.

Diagnosis: A large barb with two pairs of barbels, a weak and articulated last undivided dorsal fin ray, 41-43 scales along lateral line and generally with caudal tinged black.

Description: D 3/9; P 1/15-16; V 1/8-9; A 3/5-6; C 1/17/1; Ll 41-43; L.tr 3½-4½; predorsal scales 12-13; gill rakers 20-24. Dorsal and ventral profile more or less equally convex. Length of head 4.60 (4.31-4.97) in total length, 3.56 (3.31-3.82) in standard length, its depth 1.48 (1.40-1.71) and width 1.82 (1.56-2.04) in its length; body depth 5.24 (4.38-6.22) in TL; 4.05 (3.28-4.83) in SL; predorsal distance 2.10 (1.91-2.56), postdorsal distance 1.87 (1.67-2.10), distance from pectoral base to pelvic base 3.84 (3.30-4.40), from pelvic to anal 3.89 (3.40-4.54), length of body cavity 2.05 (1.88-2.33) in SL; dorsal situated midway between snout and caudal base, more towards snout in females, its upper edge concave; postdorsal distance 0.89 (0.73-1.03) in predorsal distance; the last undivided ray is weak and articulated, height of dorsal 4.51 (3.64-5.27) in SL and 1.26 (1.06-1.41) in HL; base of dorsal 1.43 (1.24-1.74) in its height; length of pectoral fin 4.87 (4.22-5.57) in SL and 1.37 (1.20-1.63) in HL; pelvic fin 5.7 (5.11-6.24) in SL; anal fin longer in females and when adpressed extends beyond caudal base, its length 5.23 (3.65-6.37) in SL; caudal 3.44 (2.79-4.55) in SL; depth of caudal peduncle 1.56 (1.13-1.92) in its length. Eye diameter 4.38 (3.1-5.71), length of snout 2.28 (1.97-2.58) and interorbital width 2.89 (2.42-3.39) in head length. Two pairs of barbels, the maxillary as long as eye, rostral shorter, sensory canal pores in radiating rows under eye in smaller specimens; pelvic axillary scale well developed.

Coloration: Dorsal half of the body greyish, lighter on the sides and beneath; a deep black bar behind the gill opening; the bases of scales above and below the lateral line have dark spots; the tips of caudal tinged black, more prominent in smaller specimens.

Maximum size: 270.0 mm SL.

Variation: With the possible exception of a few specimens from Kerala in which the tail is devoid of black tips, *H. kurali* shows little noticeable geographical variation in external morphological characters. This can be seen from the morphometric data of the three populations, from South Canara (with tail tipped black), Kerala (with tail tipped black) and Kerala (with tail devoid of black tips), given in Table 1. Those characters that are considered to be of basic taxonomic importance, such as the number of barbels, the scale rows along the lateral line, the scale rows between the lateral line and the base of the pelvic, the tuberculated nature of the snout, the nature of the last undivided dorsal ray, the snout length in relation to head length and the postorbital length of head remain quite constant in all the three populations and are therefore considered as different morphs of the species, *H. kurali.*

Remarks: *H. curmuca* and *H. kurali* are closely allied species but have evolved differently in the western and eastern drainages of the Western Ghats. Since *H. kolus* bears the characteristics of *curmuca* described earlier, the former is considered as a junior synonym of *H. curmuca. H. curmuca* is found in the Deccan and Mysore plateau in the Krishna, Godavari and Cauvery drainages. Day (1878, p. 573) and Beavan (1877) have recorded it from 'Central Provinces' but the fish does not occur today in Madhya Pradesh. The fish has become less common in the Peninsular rivers probably because of increased turbidity of the waters due to silting as a result of deforestation along the river banks. At present it occurs in small numbers in the Nagarjunasagar reservoir. *H. kurali* is found in small numbers in the fast flowing hill streams in forested areas in the west flowing rivers of the Western Ghats. *H. kurali* is protected in the Kolathupuzha Temple Sanctuary, Kerala.

Range: INDIA: Dakshin Kannada to Travancore hills, along the western face of Western Ghats.

ACKNOWLEDGEMENTS

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ON A NEW SUBSPECIES OF *XANTHOPIMPLA* SAUSSURE (HYMENOPTERA: ICHNEUMONIDAE) IN INDIA[1]

R. P. PATIL[2] AND P. K. NIKAM[3]

(*With a text-figure*)

A new sub species of *Xanthopimpla* Saussure (1892), *Xanthopimpla minuta aurangabadensis*, subsp. nov. belonging to Trunca species group from India, collected from India (Maharashtra: Aurangabad) is described and illustrated.

The genus *Xanthopimpla* has been catalogued by Townes, *et al.* (1961). The genus *Xanthopimpla* Saussure (1892) belongs to the tribe Ephialtini of the subfamily Pimplinae (Gupta 1987).

Townes and Chiu (1970) revised the Indo-Australian species of *Xanthopimpla* and provided a reliable key to the species of this genus; the same has been adopted in the present work. Both workers divided the species of *Xanthopimpla* into 22 species groups, of which the following 9 species groups of *Xanthopimpla* so far have been recorded from Maharashtra, India, namely (1) Regina, (2) Stemmator, (3) Citrina, (4) Cuneata, (5) Nana, (6) Brachycentra, (7) Occidentalis, (8) Punctata and (9) Incompleta. In the present work, another group Trunca has been recorded and a new subspecies, *Xanthopimpla minuta aurangabadensis*, is described.

Xanthopimpla minuta aurangabadensis

subsp. nov. (Fig. 1 a-c)

FEMALE: Body length 9.2-9.5 mm (Fig. 1b). Head (Fig. 1a) in front view 0.75 times as long as broad, vertex sparsely punctate; occiput finely punctate, shiny; temple smooth above, sparsely punctate below; ocello-occular distance equal to their diameter; interocellar distance 0.65-0.70 times the ocello-occular distance; inner margin of the eye

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[1] Accepted June 1995.

[2] P. G. Department of Zoology, P. V. P. College, Pravaranagar, Loni-413 713, Maharashtra.

[3] Department of Zoology, Marathwada University, Aurangabad-431 004.

sharply indented opposite to the antennal sockets; frons deplanate, medially elevated, the lateral concavities deep, smooth, shiny; antenna, 2+37 segmented, filiform; scape twice as long as broad; pedicel as long as broad; scape and pedicel hairy, punctate, first flagellar segment 1.50x as long as second flagellar segment; terminal segment 2.65x as long as broad; face 0.9 times as long as broad, pilose, tamidulous, with distinct coarse punctures, separated by the distance of their diameter; clypeus 0.30-0.35 times as long as broad, separated from face, subdivided by a transverse suture, basally flat, apically convex, sparsely punctate, spinose, its apical margin medially concave; clypeal fovea circular and deep; malar space 0.35 times the basal width of mandible; mandible twice as long as its basal width, provided with long hairs, punctate, equidentate and with a distinct ventral flange; occipital carina complete, strongly arched, joining at the base of genal carina.

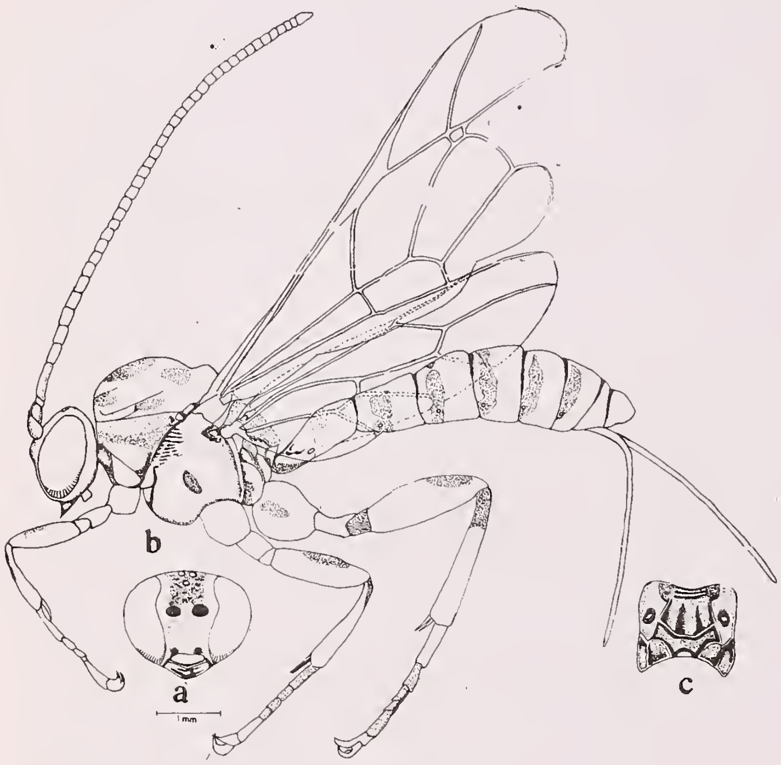

Fig. 1. *Xanthopimpla minuta aurangabadensis* subsp. nov. a. Head, front view; b. Lateral view entire; c. Propodeum.

Thorax 1.40x as long as broad, moderately pubescent, collar round, rarely pubescent; pronotum pubescent, finely punctate, weakly convex; notaulus distinct, running beyond the middle half, nearly twice the length of tegula; scutellum roundly convex, hairy, densely punctate, its lateral carina reaching up to apex; post-scutellum microsculpture same as that of scutellum; propodeum (Fig. 1c) polished, shiny, laterally sparsely hairy, distinctly carinated, basal area nearly squarish, petiolar and postpetiolar area confluent and appears pentagonal; pleural areas undivided; propodeal spiracle elongate, twice as long as broad; propleurum finely punctate; mesopleurum medially highly elevated; anterio-dorsally with a few acciculations, densely punctate, speculum shiny, sparsely punctate, its fovea shallow; prepectal carina short, reaching below the middle half of mesopleurum; post-pectal carina with median notch; metapleurum pellucid; submetapleural carina distinct, with a flange at anterio-ventral position near mid-coxa. Legs short and strong, tarsal claws very large and sharp, provided with the largest hair; hind coxae 1.25-1.30x as long as the length of the trochanters combined; hind femur 0.90 times as long as hind tibia; basitarsus subequal to the pretarsal length and twice the length of longer spur. Forewing 3.70x as long as broad; stigma five times as long as broad; the basal abscissa of radius 0.60 times the apical abscissa; nervulus slightly distad; areolet closed; second intercubitus medially fenestrated; second recurrent emits beyond the middle, geniculate, bifenestrated; discocubital cell 2.8x as long as broad; basal abscissa of subdiscoideus 1.75x the apical abscissa, nervulus half the postnervulus. Hind wing 2.60x as long as broad; nervulus intercepted above the middle, inclivous; hamuli 1+8.

Abdomen 1.55x the length of head and thorax combined, pubescent, dorsoventrally flattened; first tergite 1.75x as long as broad, laterads with a row of long hairs, subapically slightly grooved; second tergite 0.70 times as long as broad, coarsely punctate, rest of the abdominal tergites punctate; ovipositor 1.90-2.0x the length of hind tibia, long, stout, obliquely riged.

Body: Yellowish with black markings-Ocellar triangle, a transverse band dorsomedially on occiput, a mark on the outer side of the scape and the pedicel, a longitudinal band dorsomedially ending into a triangular mark near the base of the scutellum, two longitudinal bands on mesoscutum, a pair of roundish marks joined by narrow band on the basal area of propodeum, a spot below the subtegular ridge, a longitudinal mark anteriorly and a large spot on the speculum of the mesopleurum, subapical tranverse band on first tergite and trans-band basally on rest of the tergites, stigma and nervures black. Flagellum, mark on the mid femur, base of hind tibia and all tarsal segments brownish black.

MALE: Same as the female in all essential details.

Holotype: MALE: INDIA: Maharashtra: Aurangabad; and paratypes 16 females, 6 males, 8th August 1981 (Deposited in the Zoology Department of Marathwada University, Aurangabad).

DISCUSSION

In accordance with the key to the Oriental, Australian and Eastern-Palaearctic species groups of *Xanthopimpla* Saussure by Townes and Chiu (1970), *X. minuta aurangabadensis* subsp. nov. fits in the Trunca species group in the characters of areola, mesopleurum microsculpture, areolet and the largest hair tip of the mid-hind-tarsal claws. In the key to the species of the Trunca group, Townes and Chiu (1970) this subspecies resembles *X.minuta lita* Townes and Chiu (1970) in the colour pattern of the ocellar triangle, scape, pedicel and body; microsculpture of propodeum and tip of ovipositor. However, it differs from the same in having (i) a pair of black spots at the base of propodeum which are connected by a narrow band, (ii) brown mark on the mid femur and tarsals, (iii) dark-brown mark on the trochantellus, femur, base of tibia and all tarsal segments of hind leg, and (iv) black markings on the mesopleurum. In addition *X. minuta aurangabadensis* subsp. nov. is unique in possessing a black triangular mark at the base of the scutellum in continuation with median black band on the mesoscutum, lateral rows of hairs on the first abdominal segment, black mark at the base of fore wing, second geniculate recurrent and indistinct branchiella.

X. minuta aurangabadensis subsp. nov. may be included in the Key to the Indo-Australian species of Trunca group Townes and Chiu (1970), as follows:

8. Propodeum and apex of hind tibia entirely yellow: South-Eastern Asia, Ceylon and Taiwan .... *minuta minuta* Cameron (1905)
- Propodeum with a pair of black spot at base; hind tibia either apically or basally black. 9

9. Hind tibia 0.2 apically black; mesopleurum unmaculated; hind trochantellus yellow; only two apical tarsal segments black. Borneo .... *minuta lita* Townes and Chiu (1970)
- Hind tibia, 0.2 basally black, mesopleurum maculated; hind trochantellus and all tarsal segments brownish. India: Maharashtra. .... *minuta aurangabadensis* subsp. nov.

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HOMALOPTERA MENONI — A NEW HOMALOPTERID FISH (PISCES: HOMALOPTERIDAE) FROM KERALA[1]

C.P. SHAJI AND P.S. EASA[2]

(*With a text-figure*)

INTRODUCTION

The genus *Homaloptera* van Hasselt is represented by four species in the Indian subcontinent, namely *Homaloptera bilineata* Blyth, *H. modesta* (Vinciguerra), and *Homaloptera rupicola* (Prashad and Mukerji) are distributed in Burma. The genus is represented in India by a single species, *Homaloptera montana* Herre, found in Silent Valley and New Amarambalam area of

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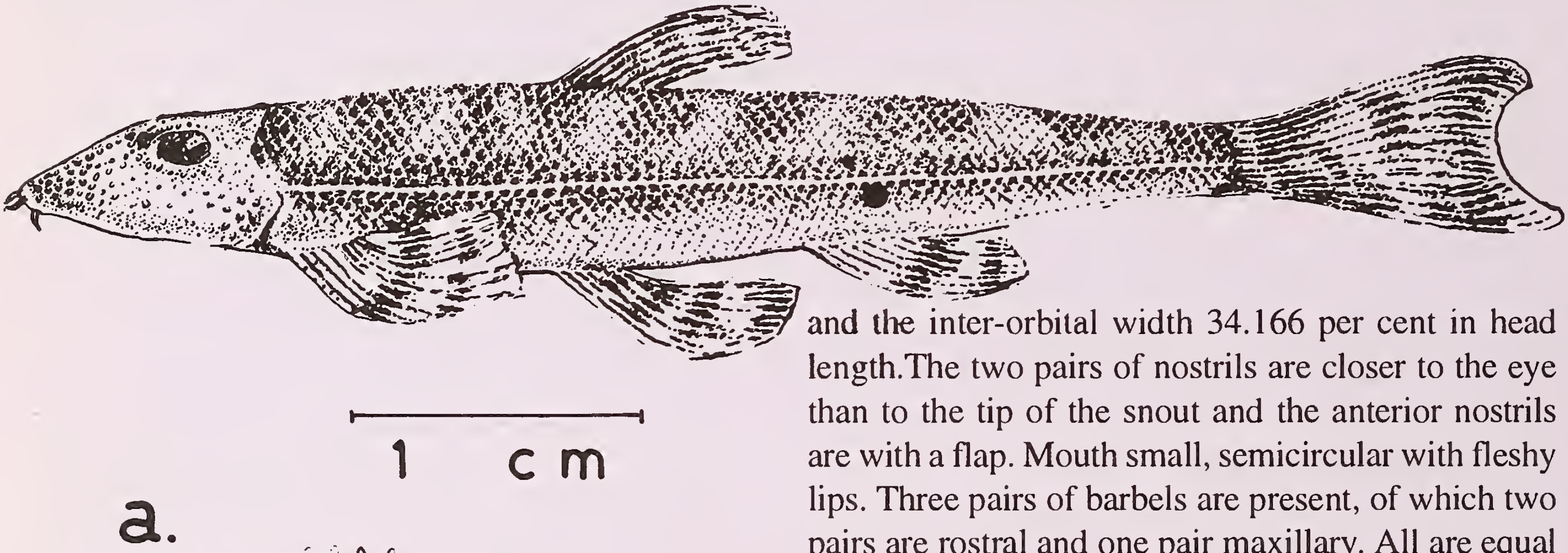
[1] Accepted June 1995

[2] Division of Wildlife Biology, Kerala Forest Research Institute, Peechi, Thrissur-680 653, Kerala, India.

Western Ghats (Menon 1987). Recently, Indra and Remadevi (1981) added a new species *H. pillaii*, but Menon (op.cit.) considered it to be a synonym of *H. montana*. Pethiyagoda and Kottelat (1994), however, treated *H. pillaii* as a distinct species. A new species of *Homaloptera* was collected from Indekkuthodu, a tributary of Bhavani River at Siruvani in the Western Ghats.

Diagnostic Characters: Body subcylindrical and covered with scales, except on the head and ventral surface. Head pointed, with four rostral barbels and two maxillary barbels. The gill-opening extends to the ventral surface for a short distance. Lips thick, continuous at an angle of the mouth and are non-pappillated. A rostral groove is absent.



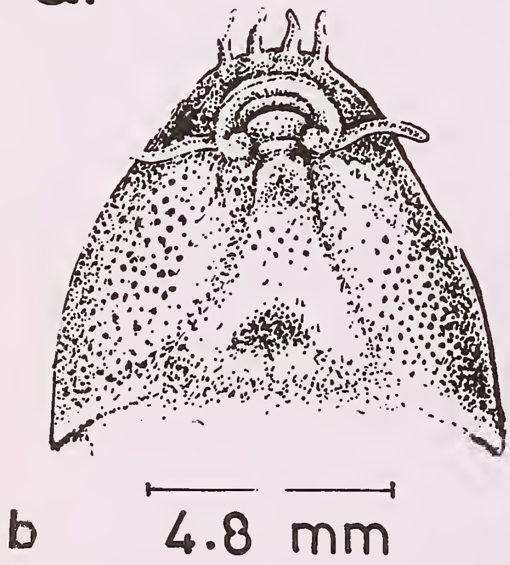


Fig. 1a. *Homaloptera menoni* sp. nov.: Lateral view of holotype.
Fig. 1b. Ventral aspect of head of *H. menoni*.

It can be distinguished from other genera of Homalopteridae like *Bhavania* by the extent of gill-opening, from *Balitora* by the nature of the lips and from *Travancoria* by the lesser number of rostral barbels and absence of the rostral groove.

Description: D 2/8 P 5/9 V 2/6; A 2/5; C 19; L.l. 59-62; L.tr. 7.5/6.5-7.

Body: Body subcylindrical and covered with scales except in the ventral parts. Depth 13.935 (13.414-14.457) per cent in the standard length (Fig. 1a).

Head: Head pointed and its length 20.605 (20.48-20.73) per cent in SL. Eyes moderately large, dorsolaterally placed and their diameter 30.33 per cent in head length. Eyes not visible from the ventral side. Length of snout 8.948 (8.536-9.63) per cent in SL, and the inter-orbital width 34.166 per cent in head length.The two pairs of nostrils are closer to the eye than to the tip of the snout and the anterior nostrils are with a flap. Mouth small, semicircular with fleshy lips. Three pairs of barbels are present, of which two pairs are rostral and one pair maxillary. All are equal in length and are equal to the eye diameter. The lips are non-papillated(Fig. 1b).

Fins: Dorsal fin situated just behind the origin of pelvic fins and its origin is closer to the tip of the snout than to the base of the caudal fin. Length 19.394 (19.277-19.512) per cent in SL. The pectoral fin hardly reaches the base of ventral and its length is 21.81 (21.68-21.95) per cent in SL. The ventral fin reaches the anal fin and overlaps the vent. Length of ventral fin 19.277 and length of anal 17.57 (17.07-18.07) per cent in SL. The vent is situated very close to origin of anal fin. Distance from vent to anal fin is 11.764 per cent in the inter-distance between origin of pelvic and anal fins. Pre-dorsal distance is 46.664 (46.341-46.987) and pre-ventral distance is 44.24 (43.902-44.578) per cent in SL.

Caudal peduncle is long and narrow. Its least width is 30 per cent in its length. Caudal fin is slightly emarginate.

Holotype: FF/KFRI/85. 41 mm standard length from Indekkuthodu in Siruvani, a tributary of Bhavani, Muthikulam forest, Palghat district, Kerala, collected by C.P. Shaji and P.S. Easa on 04-4-1995.

Paratype: One specimen FF/KFRI/86, 42 mm standard length collected from the same locality on the same day by us. All have been preserved inthe Kerala Forest Research Institute, Peechi, Trichur.

Etymology: Named after Dr. A.G.K. Menon, Emeritus Scientist, Zoological Survey of India, who has made outstanding contributions to the taxonomy of Homalopteridae and Cobitidae.

Coloration: Body is greenish yellow in ground colour with a few irregular blotches on the back of the body. The head and anterior parts of the body are mottled with black dots. Head and body have many turbercles, which, however, are absent on the ventral surface. Tubercles are also present on the anterior simple rays of pectoral fin and ventral fin. The dorsal, ventral and anal fins each have two rows of black dots.

KEY TO SPECIES OF *Homaloptera*

1. Origin of dorsal fin opposite or in front of pelvic fin .... *H. bilineata*
- Origin of dorsal fin behind origin of pelvic fin.. 2

2. A. Origin of dorsal fin equidistant between tip of snout and base of caudal fin.

a) Lateral line scales 40-45 .... *Homaloptera rupicola*
Lateral line scales more than 45 .... b

b) Lateral line scales 70-72 .... *H. montana*
Lateral line scales 83-93 .... *H. pillaii*

B. Origin of dorsal fin nearer to the tip of the snout than to the base of the caudal fin.

a) Lateral line scales 47. Least width of the caudal peduncle 42.86-50.00 per cent in its length .... *H. modesta*
- Lateral line scales 59-62. Least width of the caudal peduncle is 30.00 per cent in its length .... *H. menoni* sp. nov.

ACKNOWLEDGEMENTS

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OBITUARY

Biswamoy Biswas

(1923-1994)

(*With a plate*)

If any one cares to scrutinise the recommendations for the procurement of books for the Library of the Zoological Survey of India (ZSI), Calcutta, the biggest source of zoological literature in Asia, over the period of three decades since the independence of India, one will find that the maximum number of recommendations were from Dr. Biswamoy Biswas. A professional ornithologist, celebrated as one of the trinity of Indian Ornithology (Dr. Sálim Ali of the Bombay Natural History Society and Dr. Sydney Dillon Ripley of the Smithsonian Institution being the other two) during the second half of the 20th Century. Dr. Biswas had the habit of meticulously reading literature on many disciplines, from Protozoa to Mammalia, in Zoology, and even on 'literature' in the regional language, Bengali. This habit shaped him to be an efficient editor of scientific writings. During his tenure as the Editor of the *Proceedings of the Zoological Society, Calcutta*, the journal occupied a distinct place in the crowd of science journals of the world at large.

Biswamoy Biswas was all along a good student and had a bright academic career. He always scored high marks in all examinations since his school days. Due to his immense interest in animals, he took up Biology as one of the subjects of study during his Intermediate of Science Course, instead of Geology in which his father (a Professor of Geology, University of Calcutta) could help and guide him. He graduated from the University of Calcutta, with honours in Zoology in the year 1943, and obtained post-graduate degree of the same university in Zoology and Comparative anatomy in 1945, and was awarded the University Gold Medal for securing the highest mark in that examination.

In 1946, Biswamoy Biswas obtained a research scholarship of the Government of India for training in Systematic Zoology at the Zoological Survey of India. In the following year, he received an Overseas Scholarship and was sent abroad for three years to study the systematics of birds, specially the birds of Nepal, at the British Museum (Natural History), London, and the American Museum of Natural History, New York. At the latter Museum, he worked under the direct guidance of Dr. Ernst Mayr, a celebrity of modern Systematic Zoology, and Curator of the Whitney-Rothchild Collection and Alexander Agassi, Professor of Zoology, Harvard University. As a result of his painstaking work in these museums, Biswamoy Biswas could prepare a '*Checklist of genera of Indian birds*'. The manuscript of the 'Checklist' impressed Dr. Mayr so deeply that he readily agreed to write the foreward of this authoritative list which on publication produced a tremendous impact on progressive avian taxonomists working on birds of India and adjacent areas.

On his return from abroad, Biswamoy Biswas was appointed as the Officer-in-Charge of the Bird & Mammal Section of the Zoological Survey of India. He obtained his Ph.D. degree in 1952, under the guidance of Dr. J.L. Bhaduri of the University of Calcutta. He retired from active Government Service as Joint Director, Zoological Survey of India, in July 1981. However, his association with the Z.S.I. continued as Emeritus Scientist (from 19 September 1981 to 18 September 1986) during which period he mainly worked on the birds of Bhutan (jointly with Drs. Sálim Ali and Sydney Dillon Ripley). His last days were devoted primarily to seeing this work through the press.

It is difficult to enumerate the multifarious contributions of Biswamoy Biswas, more so to make an attempt to assess them here. Introvert as he was, Biswamoy Biswas was an ardent field worker, serious researcher and a great teacher who used to mould his students and junior colleagues without

Dr. Biswamoy Biswas (1923-1994).

they being conscious of the process.

Biswamoy Biswas "initials (BB)" became synonymous with 'Birdman Biswas' among his close associates. Indeed, he was basically an ornithologist in the true sense of the term. In the early part of his research career, he worked on the comparative morphology of certain avian organs, specially of the arterial arches, but later on concentrated mainly on the taxonomy, zoogeography, ecology and conservation of birds of the Indian sub-continent. He also made significant contributions (jointly with his mammalogist colleagues) in taxonomy and zoogeography of mammals of that area. His involvement in the conservation of wildlife in India was total. He was associated with the Indian Board for Wild Life, its Bird Wing as also with the West Bengal State Board for Wild Life since their inception in 1952. He regularly advised on revisions of the Schedules of the Game Laws and subsequently of the Wild Life (Protection) Act, 1972, as also of the various sections of the Act. He took part in the revisions of the Appendices of CITES for the fixation of quota for export of live birds, etc., from India. Dr. Biswas was responsible for writing reports of Indian National Section for the International Council for Bird Preservation as also the National Report on the Indian Wetlands (Waterfowl). He made sincere efforts and fervent plea for establishing a bird sanctuary in a portion of the Salt Lakes when the vast marshy area on the eastern fringe of Calcutta was being filled up to develop land for the township now known by that name. He took very active part in getting the Narendrapur Wildlife Sanctuary (near Calcutta) declared.

A hard taskmaster and a meticulous scrutinizer, Dr. B. Biswas was a teacher to many students who got their Ph.D. degrees under his direct supervision, but many more received his counselling and guidance which mostly went unrecognised.

He made innumerable corrections to improve the quality of countless scientific papers and desertations, be they for publication or for submission for degrees, not only in his own field of specialization but also in other disciplines of Zoology. He also reviewed practically every comprehensive publication on the birds and mammals of the Indian subcontinent. During the sixth decade of the present century, Dr. Biswas was conducting weekly field work when he could personally train a band of young workers in Field Ornithology *vis-a-vis* Field Zoology, most of whom, in later period, took leading parts in different types of survey-related programmes of the ZSI.

Dr. B. Biswas was a serious field Zoologist. A bachelor as he was, he had no difficulty in staying in the field for a substantial period of his service career, making exact observations and collecting every possible species of birds and mammals, besides other groups of animals. The concept of ecosystem-oriented field survey was not familiar in India during the earlier part of his service career. He, however, planned his field work in such a way that he could cover montane, desert, dry deciduous forest and moist evergreen forest ecosystems. Due to his experience in the central Himalaya, Dr. Biswas was attached to the 'Daily Mail' Himalayan Expedition, 1954, in quest of the abominable snowman or *Yeti* in the Mount Everest region. He conducted field work in Jammu & Kashmir, Rajasthan, Gujarat, Madhya Pradesh, Orissa, Bihar, West Bengal, Sikkim and Assam in the present Indian Union, and in the adjoining countries of Nepal and Bhutan. He visited these states on more than one occasions, while he carried out comprehensive ornithological surveys in Rajasthan, Sikkim, Nepal and Bhutan. His unpublished field records can act as an ideal guide, how serious field work should be conducted and observations recorded.

Dr. B. Biswas was never eager for honours and awards, even averse to these. However, the Asiatic Society of Bengal honoured him with Joy Gobind Law Memorial Medal in 1975, for his contributions to Indian Zoology. One of his junior colleagues paid tributes to his mentor by naming a new genus of mammal (a rare find these days), *Biswamoyopterus,* after him. Dr. Biswas was an honorary Research Associate, Laboratory of Ornithology, Cornell University, Ithaca, USA, since 1963.

Dr. Biswamoy Biswas was a member of the International Committee of the International

Ornithological Congress since 1958. He attended several sessions of IOG and World Conferences on International Council for Bird Preservation. As a member of the Indian Zoological Delegation, he visited the erstwhile USSR, in 1963.

Dr. B. Biswas conducted two projects sponsored by outside bodies. The work on the project on 'Migratory birds', sponsored by the World Health Organization — Bombay Natural History Society, was carried out (during 1964 to 1970) in the vicinity of Calcutta, initially with the help of mist nets and bird rings supplied by the Bombay Natural History Society. Later on, as a result of his special efforts, the Zoological Survey of India could procure its own stock of mist nets and rings, for this project. The other project, 'Lesser Cat Survey' was sponsored by the World Wildlife Fund — India and was carried out in nothern West Bengal and Sikkim, during 1981 — 1984.

Dr. B. Biswas, though a devoted researcher, was never a prolific writer. In publishing scientific articles, he preferred quality, rather than quantity. He was, therefore, often criticised for the alleged 'small number' of publications. During the five decades of his research career, he authored eightythree papers, most of which were written by himself alone. In some papers, which were the outcome of his joint official assignments and/or in which he contributed substantially, he shared the authorship with his colleagues and associates. The number of his publications could have easily increased several times had he agreed to accept joint authorship of papers whose initial drafts he corrected meticulously, often repeatedly. When a Ph.D. thesis is published in parts as separate scientific articles, the guide of the thesis, as per general practice, automaticlly becomes one of the authors of such papers. Dr. Biswas never agreed to such proposals and vehemently opposed them.

Dr. Biswas not only worked for science but also had a true scientific temperament. He always helped and encouraged young workers whoever came to him. His zeal for scientific persuit made him to donate parts of his savings to two different scientific organisations. He even donated his mortal body to medical students. The philanthropic faculty in him compelled him to donate a portion of his savings to a Cancer Welfare Centre.

LIST OF PUBLICATIONS

Dr. Biswamoy Biswas

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P.K. DAS

REVIEWS

1. ORNITHOLOGY OF THE INDIAN SUBCONTINENT 1872-1992. An Annotated Bibliography. By Charles G. Burg, Bruce M. Beehler, and S. Dillon Ripley. pp. 330 (27.5 x 21 cm). Washington, D.C., 1994. National Museum of Natural History. Price $ 20.00

In India no other group of wildlife has a larger following than birds. Birds have been studied in India for over a century and quarter and the interest still continues unabated.

This excellent Bibliography is most opportune to both the professional and amateur ornithologist interested in the Avifauna of the Subcontinent.

The Bibliography was ten years in the making and contains approximately 6000 references on Indian birds published since the year 1872 when Hume published the first issue of "*Stray Feathers*". The reviewer would have liked the starting date be that of the publication of Jerdons, BIRDS OF INDIA when the information on Indian Avifauna was first consolidated.

The Citations are arranged alphabetically according to the author's surname and the majority of the entries are briefly annotated enabling the reader to understand their content. An integrated index under four major keys of avian genera, avian families, geographic localities and topics of interest makes for easy reference.

This is an indispensable reference for any serious study on the avifauna of the Indian Subcontinent.

J.C. DANIEL

2. MAMMALS OF THE THAR DESERT. By Ishwar Prakash. pp. 124 (21.5 x 14 cm), with many illustrations. Jodhpur, 1994. Scientific Publishers. Price not mentioned.

This handy little book introduces the mammals of the Thar Desert region of Rajasthan. It is largely meant for the non-zoologist and provides simple descriptions of appearance, colour, size, distribution in the Thar Desert and elsewhere, of its mammal fauna with brief notes on behaviour and habits.

Fortysix species are described though all the species are not strictly desert forms and either exist on the fringe forests of the true desert or once inhabited the desert or its immediate neighbourhood. The Lion, Cheetah and the wild Ass are animals of this category.

The book has an introductory chapter on the Thar Desert and general notes on mammals. This is followed by the description of individual species, their distribution, habits and behaviour.

Each species has been illustrated, the sketches are in the majority of cases adequate, especially where the illustrator apparently had reference material. Otherwise the animals have been the subject of considerable artistic licence, notably the tiger.

A useful book especially for children helping them to familiarise themselves with the mammals of the region. One wishes that sufficient attention had been paid to proof reading.

J.C. DANIEL

3. A HANDBOOK OF THE ANGLADE INSTITUTE OF NATURAL HISTORY, SHEMBAGANUR. 2nd Revised Edition. By K.M. Mathew. pp. x + 155 (21.5 x 14 cm), with eight plates, and four maps. Tiruchirapalli, 1994, the Rapinat Herbarium, St. Joseph's College. Price R. 32/-; £ 2/-; $ 3/.

The Jesuits came to the Kodaikanal Hills in 1877 and eight years later had established a training institute, the Sacred Heart College at Shembaganur which was to become a centre of excellence in scholarship, and research in natural history, among other things.

The pursuit of Natural History resulted in the building of collections of the fauna and flora and eventually of the constitution of the Anglade Institute of Natural History at Shembaganur.

The Handbook covers the resources available at the Institute on the Anthropology, Fauna, Handicrafts, Herbarium, Arboretum, Fernery, Ochidarium and Library.

One section is devoted to the very active environment education division, afforestation, and the activities of the Palni hills Conservation Council which has done sterling work in the preservation of what is left of the depleted natural resources of the Palni Hills.

A section on Kodaikanal gives details of the Hill station and what it offers to the nature lover.

Appendices list the material resources available at the Institute.

A very useful Handbook on the natural history of the Palni hills.

J.C. DANIEL

4. ELEPHANT DAYS & NIGHTS. By Raman Sukumar. pp. xvi + 184 (24 x 16 cm), with many black and white photographs. Delhi, 1994. Oxford University Press. Price Rs. 375/-.

The Asian Elephant has its largest extant population in India. Curiously though, while scientific studies had been made on the Elephant in Sri Lanka and Malaysia, the information on the elephant in India was limited to natural history notes.

Sukumar's study, which was published as *The Asian Elephant Ecology and Management* by Cambridge University Press in 1989 was the first scientific assessment of the Asian Elephant in the Indian Subcontinent.

Since then Sukumar has continued his interest in the conservation of the elephant.

In this book he describes the story of his involvement with elephants from the time he started as a student 1980 to the present day when as Vice-Chairman of the Asian Elephant, he is able to contribute substantially to their conservation.

A very readable account indeed of the family life, reproduction, social organisation, conflict with man and other aspects of the life history of India's most fascinating animal.

J.C. DANIEL

5. NOMENCLATURE OF BIRDS OF THE INDIAN SUB-CONTINENT. By Aasheesh Pittie and Andrew Robertson. pp. vi + 106 (18 x 12 cm). Bangalore, 1993. Ornithological Society of India. Price Rs. 25/-.

The classification of birds undergoes periodic upheavals. Those who are familiar with fauna volumes in the Fauna of India series from the time of Blanford and Oates, and ECS Stuart Baker and lately S. Dillon Ripley would appreciate the turmoil. The latest addition to avian systematics is *Distribution and Taxonomy of the birds of the World* by C.G. Sibley and B.L. Monroe which is based on assessment of affinities on the basis of DNA bonds of the species. This classification was adopted as the basis for discussion by the International Ornithological Congress at their meeting in 1990.

In this Booklet the authors have listed the species of the Indian Avifauna in the order in which they appear in the new classification and for easy reference have given the Ripley's SYNOPSIS number to relate the species to earlier literature.

Present affinities and changes if any have been indicated. While uniformity is essential in scientific nomenclature, one finds it hard to accept it in the case of common names, particularly when names which have been in use for over a century are replaced by names which seem somewhat ridiculous. For instance Flameback for Goldenbacked Woodpecker! If standardisation is needed, the guiding principle should be to use the oldest extant name as one does in the case of scientific names.

The book is highly commended and is a necessary buy for all those who wish to keep in touch with current developments in ornithological nomenclature.

J.C. DANIEL

6. CHECKLIST OF THE BIRDS OF ASSAM. By Anwaruddin Choudhury. pp. 72 (21.5 x 16.5 cm), with many illustrations. Guwahati, 1990. Sofia Press and Publishers Pvt. Ltd. Price Rs. 150.00, US $ 15.00 & £ 10.00.

Here is another checklist which contains 945 species and subspecies and the figure is compared to 540 in my Checklist of Maharashtra. This appears to be extraordinarily high, particulary as the author does not appear to have had access to a reference collection but was dependent entirely on published literature. A cursory examination reveals that he has referred to 3 subspecies of the Spotted Dove (*Streptopelia chinensis) suratensis, tigrina* and *edwardi* as resident in Assam. It is possible that more than one occurs in the area but only one can be resident. I must confess that in several instances I have included more than one subspecies from Assam but it is unlikely that both are resident. This confusion is probably due to the absence of the detailed literature, a reference collection, and a proper understanding of the subspecies.

The sketches in the text are excellent and the fact that it has a hardboard cover add to its value, but the prices mentioned above certainly appear to be very high.

HUMAYUN ABDULALI

7. RECENT ADVANCES IN FISH ECOLOGY, LIMNOLOGY AND ECO-CONSERVATION. Vol. III. Editor-in-Chief Surendra Nath. pp. 131 (23.5x15.5 cm), with some illustrations. Delhi, 1994. Daya Publishing House. Price Rs. 280/-.

In the absence of the first two volumes, the reviewer was impressed by the title of the slim 3rd volume. It was only on glancing at the contents did it become clear that it was a convenient outlet for a few authors who could publish their work without having to undergo the hassles of submitting their manuscripts to a regular journal and have to take the risk of rejection slips, curtailment, etc. Out of the 16 contributions in the present volume, as many as 7 are of an "inner circle" of S.M. Das and 4 by the editor-in-chief. The geographic locations where the work was carried out are limited to Jammu & Kashmir and Himachal Pradesh (with one stray exception of Nepal), and range from the mediocre (contribution no. 4) to other, better ones. The intention to bring out a volume every year has not been fulfilled, as the first volume appeared in 1988, the second only in 1992, and the present one is dated 1994.

The first contribution deals with the status, ecology and behaviour of fishes of Arun river in Nepal. It is well presented, but I was amused by the usage by the author of the words "remote sensing", which sounded really impressive until I realised that what the author calls "remote sensing" is actually the watching of fishes by using polarised spectacles! The framing of the following sentence (p. 25) is faulty: "Fish population existing in the dam site will be depleted due to the barrier effects of dam and dewatering effects of water release in dry period is essential." Some more (insignificant) mistakes: Pages 2 and 25: fish fries (instead of "fry"), page 23: jigged and wound (should be "wounded").

The second contribution on the physical ecology of four lakes of Kumaon is a crisp, highly summarised one, and is a pleasant relief from the long, rambling discourses usually written by the author.

The two contributions by Massey cannot fit in with the subjects indicated in the title of the book (viz. ecology, limnology and eco-conservation), as one of them deals with Weberian ossicles, and the other with preparation of micro-bone structures. These two, however, will be useful to the student of fish anatomy.

Several contributions — fishes of Tehri-Garhwal, status of mahseer in the Himalayas, feeding and spawning ecology of fishes of Jammu, and fish ponds in Ladakh will be useful to biologists living in the plains who wish to keep in touch with topics on high-altitude fishes.

The last three contributions — Nanda Devi sanctuary — now a national park; biomass—problems and remedies; is Nainital lake dying-problems and remedies (all by S.M. Das) are more in the nature of review articles or recommendations by a conservation activist rather than original research work. A few excerpts: poachers should be heavily penalised and their baggage searched, impurities in water should be coagulated by alum, and sundry suggestions of like manner. Nor is the contribution "A simple method of water purification by reeds and rushes" based on the writer's original research. It is simply a re-hash of the method used in Australia and Germany. It would be very useful in the extension newsletters issued by government and NGOs to rural farmers, but does not fit in a book with the present title.

Finally, the editor's statement about incorporation of "original research work being conducted in *various* foreign universities" is substantiated by the solitary piece from Nepal, as the remaining 15 contributions are all by Indians.

B.F. CHHAPGAR

MISCELLANEOUS NOTES

1. PANTHERS EATING WATER-MELONS

Two instances have been brought to my notice last year of Panthers eating water-melons in summer. Both these cases were reported from the vicinity of the Vansda National Park in Valsad District in South Gujarat, The first incident was reported to me by a Forest Official who said he had spotted panthers eating water-melons which were grown in a river bed. In the second instance it was a pair of panthers which, in the course of one night, destroyed over sixty water melons in a field near the river.

Cases of lions eating the "Tsama" melons in the Kalahari desert of Africa have been reported by Guggisberg as mentioned by Mr. M.A. Rashid on p. 78 of his book "The Asiatic Lion".

It would be interesting to know if any one has observed similar cases concerning any of the big or small wild cats in India.

September 2, 1994 DIGVEERENDRASINH
"Digvir Nivas", Vansda-396 580,
Dist. Valsad, Gujarat State.

2. OCCURRENCE OF THE RUSTY SPOTTED CAT (*FELIS RUBIGINOSA*) IN MADHYA PRADESH

I write this to record my sighting of the Rusty Spotted Cat in Panna District of Madhya Pradesh on two occasions recently. The first time, we were motoring down the ghat on the road from Panna to Ajaigarh at about 9.00 p.m. on 13.09.93 when, rounding a curve, I noticed a cat going off the road at the lower bend. As we turned onto the road after negotiating the curve, we saw it coming down the "Pucca" — built water way from the upper to the lower road. We stopped the car and it sat down on the lower end of the water way, about 3 m from us. I quietly got out of the car with a torch and approached it till it was only 2 m away. It sat blinking and we watched it for nearly 5 minutes. Then a motor cycle came along and it walked up the same water way. I regretted that I had not taken along my camera, as I usually do.

Again, on a recent visit, on 7th July, 1994, I picked up a dead female of the same species from a little higher up on the same ghat. It had presumably been knocked down by some vehicle. This was at around 2 p.m. in the afternoon. I picked it up and got it skinned and have handed over the skin and skull to the B.N.H.S.

This area of the "Panna Ghati" is almost equidistant from Panna and Ajaigarh, being about 16 km from each town. There is a village called Vishramganj a kilometer or so from the foot of the Ghats. I wonder if this species has been recorded from this area of Madhya Pradesh. I have been informed by some local persons that they have seen this cat quite often.

Sterndale has mentioned that in 1859 or 1860 he had two kittens brought to him by a Gond in the Seoni district. Panna is situated at Lat. 24° 44' N. & Long. 80° 14' E. Seoni is at Lat. 22° 6' N. & Long. 79° 35' E. at a distance of about 400 km almost south of Panna.

In Gujarat State, this cat was first recorded by me around 1970-72 from the Dangs and Vansda area and then, in 1990, in the Gir forest by Shri B.J. Pathak.

It would be interesting to have information about the occurrence of this cat in other parts of India. While on the subject of wild cats in India, I have noticed a rapid decline in the population of the Jungle Cat (*Felis chaus*) in my area and, when discussing this matter with friends, have gathered that they too have observed this in other parts of Gujarat also. I am at a loss to understand why the jungle cat has, in the very recent past, almost disappeared from areas where it was quite common. Could it be due to trapping for sale of their skins or could it be as a result of the cats eating rats and other rodents poisoned by farmers? It would be useful to know the possible reasons for this decimation in their numbers and what could be done to arrest their threatened extinction.

September 2, 1994 DIGVEERENDRASINH
"Digvir Niwas" Vansda-396 580,
Dist. Valsad, Gujarat State.

3. FOOD OF THE SLOTH BEAR (*MELURSUS URSINUS*) IN MUNDANTHURAI PLATEAU, TAMIL NADU

A short term study was done on the food habits of sloth bear (*Melursus ursinus*) from December 1990 to March 1991 in Mundanthurai-Kalakad Tiger Reserve, Tamil Nadu. The study was carried out in Mundanthurai plateau (*c*. 60 sq. km, 08° 43' N, 76° 37' E) at an altitude of 180-200 m above M.S.L. in Kalakad-Mundanthurai Tiger Reserve (900 sq. km), South India. The common vegetation in this area includes riverine forest, dry deciduous forests and secondary vegetation. The vegetation of the plateau is dominated by plantations of *Ailanthus excelsa, Bombax ceiba, Eucalyptus, Santalum album* and *Tectona grandis*. Common tree species in the plateau are *Chloroxylon swietenia. Erythroxylon monogynum, Tectona grandis, Dalbergia latifolia. Aglaia roxburghiana* is common all along the riverine forests of Thambiraparani and Servalar.

Density of tree species was estimated from belt transects of 100 m length and 20 m width. Variables such as number of individuals and their diameter at breast height (G.B.H. cm) were recorded. Shannon and Wiener index (H') was calculated to estimate diversity of fruit trees in each transect area. Dietary composition was studied by examining scats as suggested by Landers *et al.* (1979) and Maer and Brady (1984). Fresh scats were collected on a monthly basis from game roads such as Karayar (6 km), Puckle's Path (3 km), Thulukkamottai (8 km), Gowthalayar (7 km), and Banatheertham (16 km). Entire scats were preserved in 10% formalin and washed through a wire mesh and various food particles such as seed remains of fruits, ants, termites and other materials were identified and weighed separately after oven drying. The per cent occurrence (number of scats in which a specific food item occurred/total number of scats) and per cent dry weight (dry weight of specific food item in all scats together/total dry weight of all food items for each scat separately) were estimated for each food item.

Density of food tree species (fruit bearing trees) of sloth bear indicated that one or two species have contributed more than 75% of the overall trees in each transect area. This shows uniform distribution of fruit trees in the plateau vegetation. The diversity (H') of fruit trees was slightly higher in Karayar and Puckle's Path and remaining areas had almost similar diversity values (Table 1). Highly edible fruit species such as *Grewia* spp. is widely distributed in all transects while *Aglaia roxburghiana* was restricted to Gowthalair transect.

A total of 111 scats were collected from the 5 game roads totalling 40 km in length (Table 2). Food remains of plant and animal matter were recorded from the scats. The animal material comprised 74.55% followed by 25.55% of fruit remains of the total dry weight. Plant species representing trees (3 species), shrub (1 species) and grasses were recorded from the scats. Among the plant remains *Aglaia roxburghiana* alone contributed 11.93% of the dry weight though its occurrence (5.4%) was less than that of *Ficus bengalensis* (12.6%). The latter contributed 5.3% of the total dry weight. The animal material found in the scats were termites, black and red ants and beetles. Interestingly termites alone accounted for 40.5 of the overall diet. The per cent occurrence of black ants 48.7% was also high. Beetles comprised of 14.1% of the dry weight of the overall diet.

The study showed the ability of the sloth bear to exploit successfully both animal and plant resources with regard to their availability. Plant

TABLE 1

DENSITY, RELATIVE DENSITY, RELATIVE PROPORTION AND DIVERSITY INDEX OF FRUIT TREE SPECIES IN MUNDANTHURAI PLATEAU, TAMIL NADU

Transect/species	Density/ha	Relative density	Relative proportion	H'
KARAIYAR TRANSECT				
Aglaia roxburghiana	5.00	0.100	25.00	
Cassia fistula	1.60	0.029	8.33	
Ficus bengalensis	1.25	0.022	6.25	1.23
Grewia tiliaefolia	11.00	0.200	54.17	
Syzygium cumini	1.25	0.022	6.25	
PUCKLE'S PATH TRANSECT				
Aglaia roxburghiana	15.00	0.120	45.00	
Cassia fistula	5.00	0.050	15.00	
Ficus bengalensis	1.60	0.016	5.00	1.30
Grewia tiliaefolia	10.00	0.100	30.00	
Syzygium cumini	1.60	0.016	5.00	
GOWTHALAIYAR TRANSECT				
Aglaia roxburghiana	0.71	0.008	3.12	
Cassia fistula	1.10	0.013	4.69	
Ficus bengalensis	1.43	0.017	6.25	1.03
Grewia tiliaefolia	16.43	0.200	71.48	
Syzygium cumini	1.07	0.013	4.69	
BANATHEERTHAM TRANSECT				
Aglaia roxburghiana	2.50	0.084	3.20	
Cassia fistula	1.56	0.020	9.17	
Ficus bengalensis	2.10	0.027	11.01	1.01
Grewia tiliaefolia	12.10	0.156	68.72	
Syzygium cumini	0.67	0.077	3.68	
THULUKKAMOTTAI TRANSECT				
Aglaia roxburghiana	20.00	1.073	60.60	
Cassia fistula	6.25	0.210	8.00	
Ficus bengalensis	2.25	0.029	6.25	1.01
Grewia tiliaefolia	16.00	0.200	69.17	
Syzygium cumini	6.88	0.231	8.80	

H' — Shannon Wiener index of diversity.

TABLE 2

THE PER CENT FREQUENCY OCCURRENCE AND % DRY WEIGHT OF VARIOUS FOOD ITEMS OF SLOTH BEAR IN MUNDANTHURAI PLATEAU, TAMIL NADU (N=111 scats)

Food items	Per cent frequency	Per cent dry weight
Plant matter: Trees		
Aglaia roxburghiana	5.40	11.93
Ficus bengalensis	12.61	5.30
Ficus glomerata	1.80	4.83
Shrubs		
Maba buxifolia	2.70	2.98
Grasses	4.50	0.51
Animal matter		
Termites	44.14	40.51
Black ants	48.65	19.35
Red ants	3.60	0.58
Beetles	26.13	14.11

matter did not constitute a larger proportion as the fruiting season had not commenced for many species. Ripe fruits of *Grewia* spp. was preferred by sloth bear in Dr. J. Jayalalitha Wildlife Sanctuary (Mudumalai) (Baskaran 1990), however, it was not recorded in the scats possibly as it was the non-fruiting season. Thus, it may be concluded that the higher proportion of animal matter in the diet may be related to the non-availability of fleshy fruits for the bear during the study period. Earlier studies by Laurie and Seidensticker (1977) and Baskaran (1990) have reported the importance of fleshy fruits to the sloth bear in the Royal Chitawan National Park, Nepal and in the Mudumalai Wildlife Sanctuary, Tamil Nadu respectively. However, occurrence of more animal matter in the scats during the spring was also reported by Laurie and Seidensticker (1977). It needs to be pointed out that although the study corresponded with non-fruiting season of many plant species in the Mundanthurai Plateau, fruits formed a substantial portion of the diet revealing their importance to the sloth bear.

ACKNOWLEDGEMENTS

We thank the Director, SACON for providing facilities to prepare this paper. Our sincere thanks to the Tamil Nadu Forest Department for all logistic support during V.G's stay at Mundanthurai. Dr. Ajith Kumar is thanked for his comments on the manuscript.

October 18, 1994
V. GOKULA
N. SIVAGANESAN
Sálim Ali Centre for Ornithology and Natural History, Coimbatore-641010.
M. VARADARAJAN
Department of Wildlife Biology, A.V.C. College, Mannampandal, Mayiladuthurai, Tamil Nadu.

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4. THE RATEL (*MELLIVORA CAPENSIS*) IN NORTH MADHYA PRADESH

In the last two years, the reports of sighting of ratel (*Mellivora capensis*) in the forests of Kuno-Palpur Sanctuary and other areas south of river Chambal in Morena district in north Madhya Pradesh have been coming to notice. But in almost all the cases the reporters were not sure about the identity of the animal.

Recently, a ratel entered a house in the village Barvan in the tehsil Kailaras of Morena district. Villagers, seeing a strange and ferocious animal, beat it with lathis. They captured the seriously injured ratel and handed it over to the forest officials of Deori Gharial Project on 4 August 1994. As there were serious head and neck injuries, it was not safe to release the ratel into the wild. Consequently, it was given to Gwalior Zoo on 6 August 1994. The place where it was caught has a ratel's typically preferred habitat of broken undulating country where shelter is easy to find.

A month earlier, another ratel was captured near Deori in the same district. It was released in the wild. These incidences confirm the presence of ratel in north Madhya Pradesh.

February 22, 1995
RAJIV SAXENA
MIG-853, Darpan Colony, Thatipur, Gwalior-474011 (M.P.).

5. SIGHTING OF INDIAN TREE SHREW *ANATHANA ELLIOTI* AT BORI WILDLIFE SANCTUARY, HOSHANGABAD DISTRICT, MADHYA PRADESH

Independent sightings of the Indian Tree Shrew were recorded at Bori Wildlife Sanctuary (22° 19' 28" to 22° 30' 10" N. latitude and 77° 56' 44" to 78° 20' 40" E. longitude), during the period February-June 1993. *Anathana ellioti* has three distinct populations in India. The distribution of *A.E. wroughtoni* is localised and confined to the Satpura range and a northern part of the Western Ghats.

The animal was sighted on five independent occasions while feeding on the ground. When alarmed, it instantly raced up a tree trunk disappearing into the foliage, while on one occasion the tree shrew sought refuge within a cavity in a mature teak tree. In four cases, the animal was sighted in close proximity to a nala or ravine, or actually on the slope of such a formation. In all instances, the vegetation type was moist to semi-moist deciduous forest consisting of *Anogeissus/Tectona/Diospyros/Terminalia* associations. Two sightings of the tree shrew were made in semi-moist deciduous forest patches within an overall dry deciduous zone. Such patches may be located in depressions, where a compact forest structure and dense top canopy significantly increases insulation, maintain a humid microclimate and contribute to conspicuous amounts of leaf litter and deadwood.

December 21, 1994 R.J. SHRIVASTAVA
G-18/6 DLF, Qulab Enclave-1,
Gurgaon 122002, Haryana.

6. INSTANCE OF A GREY MUSK SHREW (*SUNCUS MURINUS*) ATTACKING A FAT TAILED GECKO (*EUBLEPHARIS MACULARIUS*)

On January 31, 1994 I bagged a Fat Tailed Gecko (*Eublepharis macularius*) from Kamalnath Reserve Forest in Udaipur district. To observe its behaviour at night I kept the gecko in my residence at Jhadol in a card board box 45 x 30 x 30 cms in size. At about 1 O'clock in the night of 11-12 February 1994, while I was sleeping, I was awakened by some unusual 'shrills squeaks', searched my bedroom by the light of a torch for the source. There was nothing unusual. I then went to the kitchen and scanned the floor. To my great surprise I saw a Grey Musk Shrew (*Suncus murinus*) attacking the Fat Tailed Gecko (*Eublepharis macularius*) and the noise was being produced by the gecko. I rushed to the card board box to check whether it was the bagged gecko or a new one. The box was empty. Perhaps the gecko had escaped from the card board box and had encountered the shrew while wandering around and was attacked by it.

There is one report of the Grey Musk Shrew attacking a frog (Sharma, J.Bombay nat. Hist. Soc. 88(1): 109. 1991). On September 1, I had seen a Grey Musk Shrew eating a *Rana breviceps* at Jhadol in Udaipur district (Unpublished). These observations suggest that Grey Musk Shrew not only devours insects but can take large sized animals also.

August 31, 1994 SATISH KUMAR SHARMA
Range forest Officer,
Aravalli Aforestation Project
Jhadol (F.), Distt. Udaipur (Raj.) 313 702.

7. TWIN FOETUSES IN *HIPPOSIDEROS SPEORIS* (SCHNEIDER)

(*With a text-figure*)

The present report describes a rare case of twin foetuses in a specimen of *Hipposideros speoris* (Fig. 1). The specimen was one among the 144 bats collected on 24th April 1992, underneath the gallery of a lecture hall at Cochin and had two male foetuses, one in each uterine cornu.

Pregnancy in *Hipposideros speoris* reportedly shows a sinistral dominance in majority of the cases. However, the presence of a conceptus in both the uterine cornua raises the possibility that, single oocyte was released by both left and right ovaries simultaneously. The specimen was in its final trimester with the foetuses at full-term stages.

The present case of twins is similar to what has been reported in *Cynopterus sphinx gangeticus* (Moghe 1960) and *Megaderma lyra lyra* (Gopalakrishna *et al.* 1976) which are also monotocous bats.

A. Madhavan wishes to thank the University Grants Commission and the State Committee on Science, Technology and Environment; Government of Kerala, for the financial assistance and for all the necessary help provided.

March 22, 1995 A. MADHAVAN
Dept. of Zoology, Bharat Mata College,
Cochin-682 021.
DEEPTHI UTHAMAN
D.A. BHIWGADE
Dept. of Zoology, Institute of Science,
Bombay-400 032.

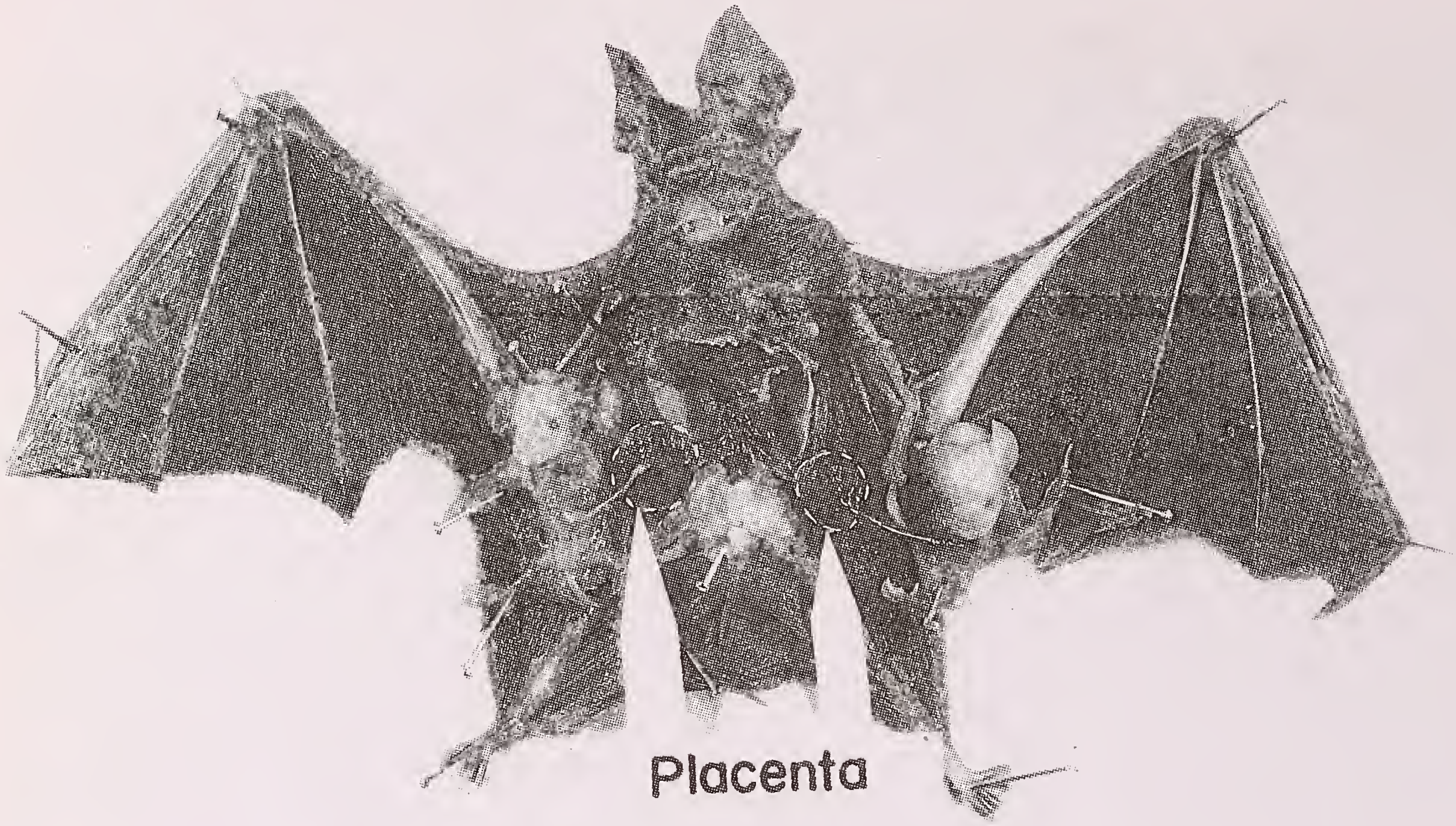

Fig. 1. The dissected specimen of *Hipposideros speoris* during full — term pregnancy. The arrows indicate placentae of the twin foetuses with individual umbilical cords in separate horns.

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8. OBSERVATIONS ON PALLAS'S SQUIRREL *CALLOSCIURUS ERYTHRAEUS* PALLAS AND OTHER SQUIRRELS IN MIZORAM, NORTHEAST INDIA

(*With a text-figure*)

INTRODUCTION

The Pallas's squirrel *Callosciurus erythraeus* occurs in many parts of the Indochinese region including all the states of northeast India, Sikkim, and Bhutan (Corbet and Hill 1992). Extensive information on its taxonomy and distribution in India are available (Khajuria *et al.* 1977, Agrawal and Chakraborty 1979). However, ecological and behavioural information is lacking, except for some studies in other countries (Tamura *et al.* 1988, Setoguchi 1990). Pallas's squirrel is not even listed in the most widely-used mammalian natural history book in India (Prater 1980). During a recent survey in the state of Mizoram in northeast India (Mishra *et al.* 1994), we were able to observe this species in its natural habitat in Dampa Wildlife Sanctuary. This report describes its field characteristics, relative abundance in different successional habitats, and other general notes on our sightings in the wild. Similar observations on three other sympatric species of diurnal squirrel are presented. We hope this preliminary note will stimulate more detailed studies on these poorly-known animals in the future.

STUDY AREA

We visited three protected areas in Mizoram: Dampa Wildlife Sanctuary in western Mirozam, Murlen National Park and Phawngpui Wildlife

Sanctuary in eastern Mizoram (Fig. 1). Dampa Wildlife Sanctuary (23° 20'-23° 47' N, 92° 15'-92° 30' E, area 500 sq. km) is a hilly area along the Bangladesh border, with the altitude ranging from 200-1100 m asl. The natural vegetation consists of tropical wet evergreen forest and moist bamboo brakes (Anon. 1989). Murlen National Park (*c.* 23° 64' N., 93° 29' E., area 200 sq. km) and Phawngpui Wildlife Sanctuary (*c.* 22° 62' N., 93° 02' E., area 50 sq. km), occurring at higher altitudes of 1000-2100 m are characterised by semi-evergreen and oak-*Rhododendron* forests. The main occupation of people in and around these protected areas is shifting cultivation or *jhum.* Most of the area within the sanctuaries has undergone *jhum* and is presently covered by bamboo (chiefly *Melocanna bambusoides*).

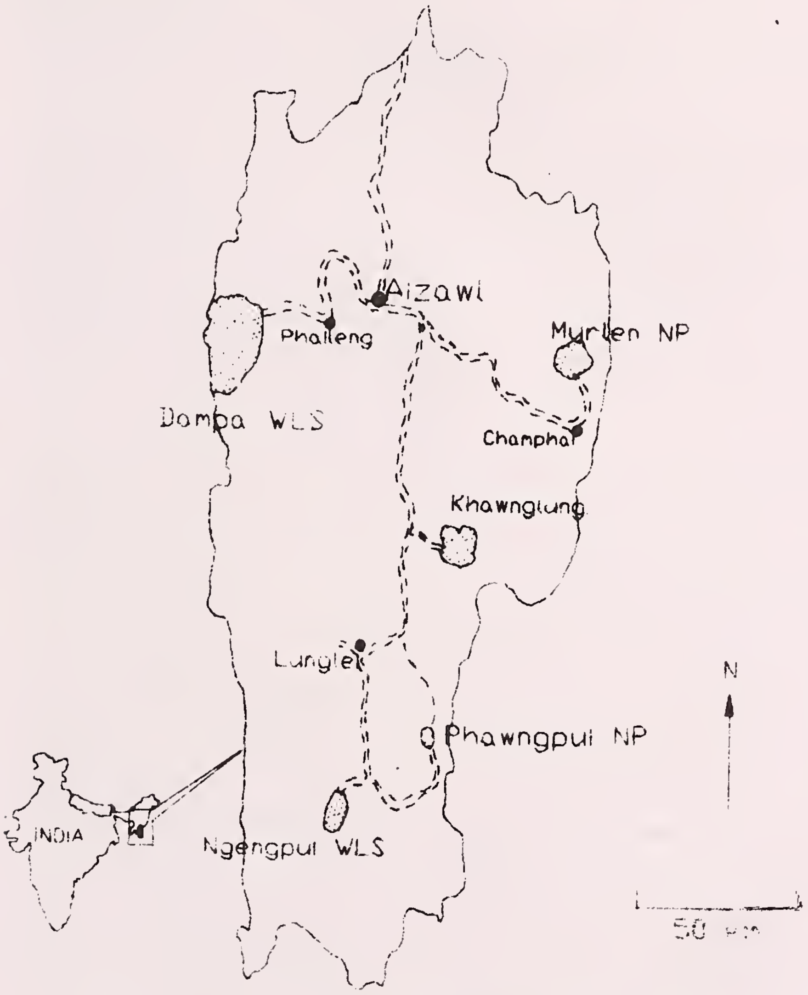

Fig. 1. Map of Mizoram showing protected areas.

METHODS

A total distance of 39.5 km was covered on foot in Dampa Wildlife Sanctuary, where most of our observations were made, between December 24, 1993 and January 4, 1994. Murlen and Phawngpui were visited for about three and five days, respectively, between January 7, and January 18, 1994. Travelling on foot along forest trails we noted, for each squirrel sighted, the species, number, height on tree, and successional vegetation type. The successional stages considered here (after Ramakrishnan 1992) were simply: almost pure bamboo forests (*c.* 5-15 years), secondary forests (of various ages, with trees > 15 years), and primary evergreen forests (which have not been *jhumed*). The distance covered in each vegetation type was measured using a pedometer.

RESULTS

Pallas's squirrel: Field Characters: The field characters of Pallas's squirrel observed during this survey are as follows: the animals were about 25 cm long (head and body) with a tail of about the same length. The dorsal region, head, face, and outside of the limbs were black. The ventral region and insides of the limbs were a rich maroon-red from the throat downwards. The bushy tail was black like the back. This description agrees well with specimens described from Assam, Meghalaya, and Manipur (Sterndale 1884, Corbet and Hill 1992).

Observations and Behaviour: Thirteen individuals of Pallas's squirrel were seen in Dampa between December 25 1993 and January 3 1994 in 39.5 km of walks along trails through the forests. Two of the sightings were of a pair of Pallas's squirrels. The remaining nine observations were of single individuals. Most of the animals were seen in primary forests, but the encounter rate in secondary forests was similar (Table 1). The animals were seen at altitudes ranging from 200 m to 1000 m. Pallas's squirrel was not seen during our short visit to the higher altitude eastern sanctuaries (Murlen and Phawngpui).

The squirrels were seen actively moving in various vertical layers of the forest, from the trunk and low lianas to the higher reaches of the canopy (5-25 m). The animals were shy of humans and scurried away on detecting our presence. Hence,

TABLE 1

SIGHTINGS OF SQUIRREL SPECIES IN SUCCESSIONAL HABITATS AND NEAR HUMAN HABITATION IN DAMPA WILDLIFE SANCTUARY, MIZORAM

Habitat	Number of sightings				Sampling	
	Malayan Giant	Pallas's	Hoary-bellied	Himal. striped.	Actual Distance (km)	Per-centage
Primary forest	6	9	1	2	22.2	56.2
Secondary	--	4	3	5	11.0	27.8
Bamboo forest	--	--	--	--	6.3	15.9
Habitation	--	--	4	--	NA	NA

NA -- Not Available.

more detailed observations could not be made. One squirrel disturbed by us made a harsh, repetitive *greek-a-greek* call. Occasionally, loud staccato calls, reminiscent of *Ratufa bicolor* but differently pitched, were heard in the forest, presumably made by this squirrel.

Other squirrels: Pallas's squirrel occurs in Dampa along with at least three other species of squirrel: the Himalayan hoary-bellied squirrel (*Callosciurus pygerythrus*), the Himalayan striped squirrel (*C. macclelandii*), and the Malayan giant squirrel (*Ratufa bicolor*). Eight individual hoary-bellied squirrels (mainly in secondary forests and habitation — Table 1) and seven Himalayan striped squirrels (two solitary individuals in primary forest, one in secondary forest, and two pairs in secondary forest) were seen in Dampa. The Malayan giant squirrel was seen on six occasions and heard twice exclusively from tall, primary forests. Of these squirrels, the Himalayan striped and Malayan giant were also seen in Murlen National Park. In five days in Phawngpui Wildlife Sanctuary, we recorded the Himalayan striped, and hoary-bellied squirrels. Further observations were not possible because of the short duration of our visits.

DISCUSSION

At least four species of diurnal squirrels, and an unknown number of flying squirrel species occur in Mizoram. Another species, the Himalayan orange-bellied squirrel (*Dremonys lokriah*) was recorded in Phawngpui during an earlier survey (Rai and Johnsingh 1993). This species is reported to occur at higher altitudes than the hoary-bellied (Prater 1980), and may thus be confined distributionally to the higher ranges of eastern Mizoram. In terms of conservation needs, the main threat in many areas is habitat alteration due to *jhum*. The Malayan giant squirrel which appears to be restricted to the tall, undisturbed primary forests (MacKinnon 1978), may be the most affected by such habitat alteration. The Pallas's squirrel, occurring in both secondary and primary forests, is probably less prone to such pressures. During this survey, no squirrels were seen in 6.3 km of walks through pure bamboo forests (Table 1) which represent the arrested successional vegetation arising from short *jhum* cycles of less than 15 years (Ramakrishnan 1992). This vegetation dominates most of the area in Dampa and Phawngpui, as well as areas outside the sanctuaries. The regeneration of bamboo forests into later successional stages is likely to improve the habitat for squirrels in Mizoram.

Hunting by local people may be another threat to squirrel populations. Most birds and mammals, including squirrels, are hunted by the Mizo people. During our visits to hunters' houses, we found tails of squirrels (presumably Malayan giant squirrel) displayed along with trophies of several other animals.

Despite the fact that most of the habitat and associated flora and fauna have been lost to *jhum* and hunting, the conservation outlook in Mizoram appears quite positive. The Mizoram forest department has taken commendable steps towards wildlife conservation in the state. Of the total land area of 21,087 sq. km, 1647 sq. km are protected forests and 6,400 sq. km are Reserved forests (Anon. 1989). In Dampa, eleven villages were successfully shifted out of the sanctuary and *jhum* is now disallowed. Similar measures are being undertaken in Murlen and Phawngpui. Information on the effectiveness of these measures, and comprehensive studies of squirrels in the region would be of value.

ACKNOWLEDGEMENTS

The Director, Wildlife Institute of India is thanked for his support. We are indebted to the Mizoram Forest Department for funding this survey and making our stay enjoyable. We would especially like to thank: Messrs. C. Ramhluna, C.P. Oberai, Ramthanga, G. Kumar, Lalrinmawia, N.R. Pradhan, and Lal Fala in Aizawl. We are grateful to Messrs. Kimthanga, Lakhan Joey, Lalchangliana, B. Khupa, Kama, Chanuk and others for help in the field. We thank other friends in Aizawl and W.I.I. for much help and discussion.

August 31, 1994

T.R. SHANKAR RAMAN
CHARUDUTT MISHRA
A.J.T. JOHNSINGH
*Wildlife Institute of India, P.B. No. 18, Chandrabani,
Dehradun 248 001, India.*

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9. AN ASSESSMENT OF TILLER DAMAGE BY RODENTS IN IRRIGATED RICE FIELDS

Of the 15 rodent species of economic importance in India, (Chopra 1988) the lesser bandicoot rat, *Bandicota bengalensis*, the soft furred field rat, *Millardia meltada* and the Indian field mouse, *Mus booduga* inflict extensive damage to rice crops in Northern India (Chopra 1988) and in Cauvery delta, Southern India (Jayaraman and Velayutham 1977). But, quantified data on the rodent population and their depredation on rice crops of different developmental stages from Cauvery delta are meagre and hence the present investigation.

We studied tiller damage by the rodent pests in the transplanted rice fields near Vilanagar and Arupathy villages of Nagapattinam Quaid-Milleth district (11° 2' N, 79° 49' E), Tamilnadu. The Study was conducted between June 1993 and August 1993 (Kuruvai season) on four successive developmental stages, namely vegetative, milky, panicle formation and maturation of rice crop (Variety: ASD 18) to determine the suitable period for a rodent control campaign.

Three hectares of rice field were taken for the estimation of rodent population and assessment of crop depredation by them. We adopted live burrow count method (Barnett and Prakash 1975) for rodent population estimation and diagonal method (Neelanarayanan *et al.* 1993) for their damage appraisal. In the diagonal line of the selected plots (6 plots of 0.5 ha size) at every 10 m interval, 0.0929 m quadrats were laid and the damaged and undamaged tillers were enumerated. The percentage of damage was then computed by using the enumerated damaged and undamaged tillers.

Live burrows of the three species of field rodents were the least during the vegetative phase of rice crop and the highest during maturation phase (Table 1). The early stage or the vegetative stage of rice crop was not infested by rodent pests. The tiller damage started during milky stage and it showed an increasing trend in the subsequent developmental stages. The extent of rodent depredation was at its maximum (31.8%) in the maturation stage of the rice crop (Table 1).

The results showed that when the rodent population increases, the damage values also increase in all the four successive developmental stages of crop fields. Besides, immigrants might have also caused large tiller cut damage in the late developmental stages of rice crop. Therefore, the control campaign must be started against rodent pests when their population is at its minimum, i.e. during either late vegetative stage (30 days after transplantation) or at the inception of the milky stages of rice crop so as to reduce greater grain loss due to rodents.

Table 1

POPULATION OF RODENTS AND THEIR DEPREDATION TO RICE CROP IN FOUR SUCCESSIVE DEVELOPMENTAL STAGES

Rice developmental stages	Population of rodents Live burrows (No./ha) *B. bengalensis*	*M.meltada*	*M.booduga*	Percentage of tiller damage/ha
Vegetative (1-30 days)	5	3	1	0
Milky (31-45 days)	11	6	2	9.66
Panicle formation (46-60 days)	13	7	1	30.3
Maturation (61-80 days)	15	10	7	31.8

ACKNOWLEDGEMENTS

We are indebted to the Principal and Management of A.V.C. College (Autonomous) for providing facilities and encouragement to carry out this work successfully. We are also thankful to Mr. K.S. Subiah and Dr. R.P. Mathur, Pest Control (India) Ltd., Madras for encouragement. Our thanks are also due to Messrs R. Balu, V. Elangovan for their assistance during the study.

December 26, 1994

P. NEELANARAYANAN
R. NAGARAJAN
R. KANAKASABAI
Division of Wildlife Biology, A.V.C. College (Autonomous), Mayiladuthurai-609 305, Tamil Nadu.

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10. STATUS OF WILD ELEPHANTS IN DIBANG VALLEY OF ARUNACHAL PRADESH

The Dibang Valley district of Aruanchal Pradesh (27° 50' to 29° 30' N and 95° 15' to 96° 40' E) was formerly a part of Lohit district. About 60 per cent of the total area of the district are under different types of forest. During visits to the area (September and December of 1992; February, March and May of 1993; and February and March of 1994), I assessed the current status of the Wild elephant (*Elephas maximus* Linn.) in the district.

The Wild elephant once ranged throughout the southern areas of the district. Their northern limit was the foot of the Mishmi Hills, which rise almost abruptly from the plains. The entire alluvial fan (Bhabar tract), with its gentle slope, from Dambuk in the west and Roing in the east, was inhabited by the elephants.

In the seventies, large-scale settlement took place between Santipur and Roing which continued till the eighties. Even now, many new settlements are coming up, mostly of Adi tribe (formerly called the Abors) from western Dibang Valley and Siang districts. Almost the entire lowland evergreen forests have been converted into cultivation resulting in a wide gap in elephant-habitat. Some elephants continued their movement through the gap even in early eighties also, but since about mid-eighties, it has completely ceased. The gap is now *c.* 20 km wide.

At present, the Wild elephant is found in two disjunct parts, one in the south-west and the other in south-east of the district. The western range is larger and comprises the Dibang, Kerim and part of Deopani Reserved Forests (RF). The northern limit of elephants in this area is *c.* 5 km south of Dambuk. An estimated 50 to 100 elephants roam in the area at different times of the year. This elephant population regularly moves towards west by crossing the Sesseri river to East Siang district, especially D'Ering Sanctuary, then to Dibru-Saikhowa Sanctuary of Assam. Some also occasionally move towards the south to Amarpur area and Sadiya Station RF (north block) of Assam.

The eastern population moves in the southernmost areas of Mehao Sanctuary, Hajing proposed RF and some unclassed forests. This population migrates to Lohit district by crossing the Difu river and also to Kundil Kaliya RF of Sadiya (Assam). The estimated population of pachyderms fluctuates between 30 and 60.

The total number of elephants in Dibang Valley district ranges from about 80 to 160, with a potential habitat of about 400 sq. km. The elephant-census carried out by the Forest Department in March, 1993 (I was camping in Dibang RF) puts the figure as 139 for the district at that time.

December 29, 1994

ANWARUDDIN
CHOUDHURY
Near Gate No. 1 of Nehru Stadium,
Islampur Road, Guwahati 781 007, Assam.

11. OCCURRENCE OF ALBINO LESSER WHISTLING TEAL, *DENDROCYGNA JAVANICA* (HORSFIELD)

While taking part in the annual Waterfowl Census organised by the Asian Wetland Bureau, I visited South-Eastern Railway Centenary Bird Sanctuary on 13th January 1994, situated at Santragachi, 7 km South-West of Calcutta, in the District of Howrah. The Jheel is about 200 m long and 50 m wide. The Census revealed the presence of 3000 Lesser Whistling Teal (*Dendrocygna javanica*). Among them was one very white duck. We overlooked the bird assuming it to be a domestic one. However, on closer observation, it was revealed that the bird was not feeding like its other domestic cousins nearby. Instead it was sleeping with its head tucked on its back like other Lesser Whistling Teals. A telescope of magnification 60X was used, to take a closer look. The bird was pure white and had a pink bill, instead of the usual slaty grey bill of the Lesser Whistling Teals.

Meanwhile, a Pariah Kite (*Milvus migrans*) appeared and created an alarm among the ducks. The albino duck was also alarmed and looked up at the sky like other Teals, while the domestic ducks remained relaxed making it obvious that this albino duck was not a domestic one.

During a visit to Kalyani Lake — 60 km North of Calcutta, in the District of Nadia — another albino Lesser Whistling Teal was sighted. Though I could not confirm as to whether it was the same duck, the tendency of ducks to move from one jheel to another makes it a strong possibility. Kalyani Lake is 100 m long and 25 m wide. The distance of Kalyani Lake from South-Eastern Rly. Centenary Bird Sanctuary is about 65 km.

July 29, 1994

SUJAN CHATTERJEE
DB-75, Salt Lake City, Calcutta 700 064.

12. OCCURRENCE OF RED-LEGGED FALCON, *FALCO VESPERTINUS* LINN. AT AAKKULAM, KERALA STATE

I was able to observe a rather small falcon on 29.11.93, 30.11.93, 1.12.93 and 2.12.93 haunting a scrub covered hillock at Aakkulam, Ullur Panchayat (Lat. 8° 30' N. and Long. 76° 55' E.), South Kerala.

The bird resembled a female kestrel, but was of smaller size, longer wings which extended a little beyond the tail which was strongly barred, brown head and upper neck, slaty grey upper parts and red legs set it apart at a glance. It was very confiding and allowed close approach and on all days I was able to observe it at close range using a pair of 8 x 30 binoculars. Moreover, its habit of frequenting exposed perches facilitated clear and uninterrupted watching and consequently all the field marks could be noted. Even the soft parts, namely the orange beak with black tip and the red legs were noted. The habits of this handsome falcon were typical of its genus, but it appeared to be more active during evenings till dusk advanced. It would invariably be found seated on telephone poles and other such exposed perches during the day, the favourite perch being a dead *Albizzia* tree about 6-7.5 m tall. The usual style of flight when flying from one perch to another was swift and dashing but often glided smoothly when it had to reach a perch lower down from a higher one. As dusk fell, the falcon after soaring for 7-10 minutes, retired to a well-wooded patch where it presumably roosted. The bird was tolerant of the mobbing of crows, tree-pies, and sunbirds but seemed to avoid the more persistent 'scolding' of drongos. Considerable agility was displayed in evading pursuing drongos by veering to one side abruptly. I never saw it hovering or attempting to capture any prey. No calls were heard.

According to the SYNOPSIS, this falcon is a passage migrant to India, where most records were obtained from SW. India. It is further said that the passage takes place rather late, i.e. from October-December. Few birds straggle to Sri Lanka. While comparing my field notes and sketches with the HANDBOOK and other field guides, it seems rather safe to conclude that this bird was a female Redlegged or Redfooted falcon (*Falco vespertinus*). So it would be worthwhile for birdwatchers in SW. India, particularly Kerala to keep a look-out for this falcon during the next autumn passage season and provide additional details on general behaviour and habitat requirements.

ACKNOWLEDGEMENTS

I am thankful to Mr. Rajkaran who informed me of this bird at Aakkulam and my friend Jeevan who helped in noting down the details.

November 7, 1994

MANOJ V. NAIR
34 Thoppil Nagar,
Kumarapuram,
Trivandrum,
Kerala-695 011.

13. OCCURRENCE OF SWAMP PARTRIDGE, *FRANCOLINUS GULARIS* (TEMMINCK) IN ARUNACHAL PRADESH

'D'Ering Memorial Wildlife Sanctuary in East Siang District of Arunachal Pradesh consists of 190 sq. km riverine and island areas of Siang and Sibia rivers. The sanctuary has its southern boundary with Assam. The vegetation of the sanctuary consists of grasslands with scattered growth of *Zizyphus*, and patches of forest with *Albizzia, Simal, Erythrina, Musa, Anthocephalus, Dillenia* and other tree species. *Imperata* (thatch grass), *Saccharum* and *Phragmites* are the main grasses of the area. The land area which consists of one main island (Lali Chapori) and few quite small islands, undergoes seasonal flooding. There are quite a few wetlands scattered all over the main island. Cutting and burning are habitat management practices carried out in the sanctuary. The sanctuary supports a large number of wetland birds besides the rare Bengal florican. Tiger, Leopard, Barking deer, Elephant, Wild buffalo, Wild boar, Common otter and Jackal are the mammals reported in the sanctuary.

During my visit to the sanctuary in December, 1991 I sighted two partridges on a jeepable path in the thatch area. But the sighting was momentary and the birds flew to the adjoining patch of thatch. Rusty red throat and overall colour of the bird pointed towards Swamp partridge, but the record remained unconvincing. The Wildlife staff accompanying me when shown the picture were sure of Swamp partridge occurring in the area. Still, I waited for further confirmation. During my last visit to the area, I heard on 29th January, 1994 the bird calling around 8.15 a.m. in the thatch growth on the right bank of Sibia river near Namsing camp. The call of the bird was the unmistakable *qua, qua, qua.*

The Swamp Partridge is reported from Assam and its occurrence in suitable habitat in the adjoining areas of Arunachal Pradesh is quite obvious. Further east of 'D'Ering Wildlife Sanctuary there is a good extent of area with similar habitat features and there is every likelihood of the occurrence of Swamp Partridge there.

February 24, 1994 PRATAP SINGH

Dy. Conservator of Forests (WL),
C/o C.C.F. (Wildlife, Wetlands & Vigilance),
Itanagar-791111, Arunachal Pradesh.

14. SLENDERBILLED GULL *LARUS GENEI* BRÈME IN NEW DELHI

To the various sightings of the Slenderbilled Gull *Larus genei* Brème published in recent years in the Society's *Journal*, a sighting from Okhla Barrage, New Delhi on 21st January 1990 has now to be added. A singleton seen on that date during the Asian Midwinter Waterfowl Census was associated with Brownheaded- and Blackheaded gulls. The Slenderbill's pure white head, its longer white neck, and an elongated (*v.* rounded) head, lacking ear-coverts, and its red bill were conspicuous pointers to its identity.

May 15, 1990 VIVEK MENON

P.O. Box 3150, New Delhi-110 003.

TARA GANDHI

Nehru Centre, 8, South Audley St., London, W1, UK.

MOHIT AGGARWAL

E-198, Amar Colony, Lajpat Nagar, IV, New Delhi.

RAJESH THADANI

A-17, Mayfair Gardens, New Delhi-110 016.

15. INDIAN RING DOVE *STREPTOPELIA DECAOCTO* (FRIVALDSZKY) NESTING IN AN ABANDONED NEST OF THE GREY SHRIKE *LANIUS EXCUBITOR* (SYKES)

On 8th February 1994, I found a nest of an Indian ring dove (*Streptopelia decaocto*) with two eggs placed inside an abandoned nest of the grey shrike (*Lanius excubitor*) in the Great Indian Bustard

Sanctuary, Nannaj (Maharashtra). The nest of the shrike was located in the middle canopy of a white acacia (*Acacia leucophloea*) tree, 1.5 m above the ground. The dove had used a few twigs for its nest within the shrike's nest. The old nest hosting the dove's nest was known since I had marked this nest (of the shrike) for observations. The nest of the shrike consisted of twigs of *Acacia* spp. having long thorns but the inside was lined with softer twigs. There was very little chance of predators reaching the nest, so probably this could be the reason for selecting such a nest-site by the dove.

This kind of unusual nesting site has been recorded in Redvented bulbul (*Pycnonotus cafer*) by Sivasubramanian and Sundaramoorthy (1992). There is no report of such behaviour available on Indian ring dove in the standard reference books on birds of the Indian subcontinent (Ali and Ripley 1987, Roberts 1991). Also such behaviour of this species is not reported by Goodwin (1983).

May 9, 1994

SATISH KUMAR
Bombay Natural History Society,
Hornbill House, Dr. Sálim Ali Chowk,
Shaheed Bhagat Singh Road,
Bombay-400 023.

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16. THE GREAT REED WARBLER *ACROCEPHALUS STENTOREUS* (HEMPRICH & EHRENBERG) FEEDING ON FRUITS OF *SALVADORA PERSICA*

On January 18, 1994 we completed our Waterfowl Census at about 1730 hrs on Pariej reservoir (22° 33' N, 72° 38' E), Kheda district, Gujarat. While walking on the reservoir bank, we saw two small passerines actively searching for food on *Salvadora persica* tree. We closely observed the birds through our 10 x 50 binoculars and to our surprise found that the small passerines were Indian Great Reed Warblers *Acrocephalus stentoreus* and they were feeding on the ripe fruits of *S. persica.* We watched their feeding activity for more than 15 minutes. The warblers searched for the ripe fruits in the entire canopy.

According to Ali and Ripley (1983), the Great Reed Warbler is insectivorous; and there is no published report on its fruit eating behaviour. There are several reports where reputedly insectivorous birds have occasionally been observed feeding on fruits or flowers (Child 1978, Moeed and Fitzgerald 1982, O'Donnell and Dilks 1989). During bad weather many wintering insectivorous birds turn to other source of food such as buds and fruits (Tinbergen 1960, Jackson 1979). It is quite likely that Great Reed Warbler might be finding it difficult to find insect food during winter. The fruits of *Salvadora* being easily available, might have been consumed to meet its energy requirement. It would be interesting to know the importance of fruit eating by this species of warbler during different seasons of the year.

May 9, 1994

B. M. PARASHARYA
A. G. SUKHADIA
D. M. MEHTA
R. B. CHAUHAN
AICRP on Agricultural Ornithology,
Gujarat Agricultural University,
Anand Campus, Anand 388 110.

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SATISH KUMAR
Bombay Natural History Society,
Hornbill House, Dr. Sálim Ali Chowk,
Shaheed Bhagat Singh Road,
Bombay-400 023.

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16. THE GREAT REED WARBLER *ACROCEPHALUS STENTOREUS* (HEMPRICH & EHRENBERG) FEEDING ON FRUITS OF *SALVADORA PERSICA*

On January 18, 1994 we completed our Waterfowl Census at about 1730 hrs on Pariej reservoir (22° 33' N, 72° 38' E), Kheda district, Gujarat. While walking on the reservoir bank, we saw two small passerines actively searching for food on *Salvadora persica* tree. We closely observed the birds through our 10 x 50 binoculars and to our surprise found that the small passerines were Indian Great Reed Warblers *Acrocephalus stentoreus* and they were feeding on the ripe fruits of *S. persica.* We watched their feeding activity for more than 15 minutes. The warblers searched for the ripe fruits in the entire canopy.

According to Ali and Ripley (1983), the Great Reed Warbler is insectivorous; and there is no published report on its fruit eating behaviour. There are several reports where reputedly insectivorous birds have occasionally been observed feeding on fruits or flowers (Child 1978, Moeed and Fitzgerald 1982, O'Donnell and Dilks 1989). During bad weather many wintering insectivorous birds turn to other source of food such as buds and fruits (Tinbergen 1960, Jackson 1979). It is quite likely that Great Reed Warbler might be finding it difficult to find insect food during winter. The fruits of *Salvadora* being easily available, might have been consumed to meet its energy requirement. It would be interesting to know the importance of fruit eating by this species of warbler during different seasons of the year.

May 9, 1994

B. M. PARASHARYA
A. G. SUKHADIA
D. M. MEHTA
R. B. CHAUHAN
AICRP on Agricultural Ornithology,
Gujarat Agricultural University,
Anand Campus, Anand 388 110.

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17. THE BLUETHROAT *ERITHACUS SVECICUS* (LINN.) IN KERALA

According to Ali (1969) the Bluethroat is a regular winter visitor to northern Kerala, e.g. the Wyanad, and is found in marshy reed-beds, and irrigated paddy crops.

At Elapully, about 15 km east of the Palakkad town in the Palakkad district in Kerala this species has been regularly noted in a sugarcane field since 1992. A female was first observed on January 21, 1992 and thereafter regularly. In 1993 also one female was seen, but in 1994 a pair was seen on January 12, 1994. The previous years' birds were rather silent with only the 'Chuk-Chuk' or 'Tack-Tack' notes. In 1994 I saw the male singing.

According to Whistler (1963) "the alarm-note and ordinary call is a harsh 'Tack'. In the HANDBOOK Ali and Ripley (1983) say that the call is a "harsh subdued chur — or chuck, chuck... sometimes also heard in winter quarters in April from belated migrants." So that it may be assumed that 'chur-chur' or 'chuck-chuck' or 'tick' could be expected from it though it is otherwise very musical during its breeding season.

The present individual is an exception. Every morning at about 0630 to 0640 hrs. he comes out of his roost in a sugarcane field, sits on a mount in a field-bund, pours out for about 10 minutes various melodious notes continuously. The song is a melodious, sweet, and loud musical warbling. It begins something like "chirkucheri-ri-ri-rli-rli-rli" and then 5 or 6 continuous repetition and rolling of this mixed with warblings followed by a curious musical rattling which become gentle and tails off. Sometimes the song also begins with 'Ting Ting Ting-Ting-Ting" and just before commencing the same, it dips its head and turns it left and right two or three times then raises the head and the song comes out endlessly. During this time the tail is constantly flicked and cocked. This feat is performed sometimes from two or three places. Such a musical feat is performed before roosting also, which it does on the sugarcane plant. Event at about 6 p.m. the bird was very active and the method of feeding was also interesting. It looks around for sometimes (2 or 3 turnings) then dips its head and runs forward 3-4 steps keeping the head down, stops and pecks. The bird was not seen from 18th February onwards and till it left sang every day.

October 18, 1994

L. NAMASSIVAYAN
Advocate,
Kerala Natural History Society,
"The Wilderness", Elappully Post,
Palakkad-678 622,
Kerala.

18. SUGARY EXUDATE OF SORGHUM *SORGHUM BICOLOR* AS FOOD OF LARGE GREY BABBLER *TURDOIDES MALCOLMI* (SYKES), PURPLERUMPED SUNBIRD *NECTARINIA ZEYLONICA* (LINN.) AND REDVENTED BULBUL *PYCNONOTUS CAFER* (LINNAEUS)

In Solapur district of Maharashtra, 'Rabi crop' of sorghum (*Sorghum bicolor*) gets infested by aphids and jassids. The major causal organisms of this disease are the aphid species mainly *Rophalosiphum maidis, R. saccri* and jassids and delphacids. These insects invade leaf laminae from the ventral side and suck their cell sap. Because of such infestation, a honey-dew like liquid sugary secretion and a thin exudate comes out from leaf blades through the pores created by these pests, which falls on the lower leaves and finally trickles down to the ground. Due to the presence of these secretions, "black-sooty mould" is developed which causes a pathological disorder in the crop plant (blackening of the infected leaves) and hinders its photosynthetic activity. The technical term for the disease is *Botroitis cinneria.*

The disease is locally recognised as of two types: '*sakhari chikta*' and '*teli chikta*'. The former is caused by jassids (at low temperatures of November and December) and the latter by aphids (at low and high temperatures from December onwards).

The sugary exudate after sometime is condensed into crystals on the leaves. I observed three species of birds, namely Large grey babblers *Turdoides malcolmi,* Purplerumped sunbirds *Nectarinia zeylonica* and Redvented bulbuls *Pycnonotus cafer* feeding regularly on these crystals of carbohydrates in the crop-fields around the Great Indian Bustard Sanctuary, Nannaj, Solapur (Maharashtra).

May 4, 1994

SATISH KUMAR
Bombay Natural History Society,
Hornbill House, Dr. Sálim Ali Chowk,
Shaheed Bhagat Singh Road,
Bombay 400 023.

19. AN UNUSUAL NESTING SITE OF HOUSE SPARROW *PASSER DOMESTICUS* (LINN.)

The House sparrow (*Passer domesticus*) prefers hollows in buildings and masonary wells; holes in trees, earthbanks; nests of swifts and swallows and even cliffs for placing its nest (Ali and Ripley, HANDBOOK compact edition, 1983). In the month of May 1994, my family experienced an interesting case of nesting by a pair of House Sparrows at my house at village Mohammadpur in Alwar district.

During the first week of May 1994, a pair of house sparrows were seen frequently entering one of the legs of a pair of pants which was hanging on a peg, on the southern wall of the verandah of my house. After a few days, the pair was seen bringing and depositing fibres in the selected leg of the pants. Obviously the birds were nesting there. Since the pant's leg was a hollow pipe without a plug, many small fibres fell on the floor. To check this loss, my mother placed a rubber band at the mid point of the selected pant's leg. This proved a boon to the nesting birds and soon they succeeded in completing the nest. Eventually the brood was successfully raised by the birds.

Twenty years ago, most of the houses in my village had thatched roofs made by culms and leaves of *Saccharum bengalense,* a locally available tall grass. Thatched roofs were one of the ideal sites for nesting of house sparrows. But due to increasing tendency of making houses *pucca,* nest locations are difficult to find for nesting sparrows. Perhaps scarcity of traditional nesting sites forced the sparrows to select such alternate sites.

July 14, 1994

SATISH KUMAR SHARMA
Range Forest Officer,
Aravalli Afforestation Project,
Jhadol (F.), Distt. Udaipur,
Rajasthan-313 702.

20. NESTING OF *PLOCEUS PHILIPPINUS* (LINN.) ON PERSIAN WHEEL

A variety of plants and other structures are selected by Baya Weaver Bird *Ploceus philippinus* for nesting. Broadly speaking, such nesting sites can be categorised into two types, namely 'vegetational' and 'non-vegetational' (structures). Different species of trees, shrubs, etc., constitute the vegetational site. Besides traditional vegetational site, two types of non-vegetational sites, namely eaves of houses

(Davis 1971) and telegraphic and power lines (Ambedkar 1969, Venkataramani 1981) are known. During the monsoon season of 1993, I observed a third type of 'non-vegetational' site near village Oda in Jhadol tehsil of Udaipur district. I noticed two completed nests of *P. philippinus* hanging from different projections of a wooden persian wheel, installed in an old well for irrigation. Both the nests were hanging on the extreme tips of two different spokes projecting from the circular rim of the wheel at two different points towards its lower side.

This wheel has not been used for the last one year. No vegetation was present on the walls of the well. Nesting on vegetation, present in wells, have been reported by many workers (Ali 1931, Crook 1960, 1963) but nesting on structures, present in well, is first recorded here.

February 8, 1994 SATISH KUMAR SHARMA
Range Forest Officer,
Aravalli Afforestation Project,
Jhadol (F.), District Udaipur,
Rajasthan 313 702.

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21. OBSERVATIONS ON THE NARROW-HEADED SOFTSHELL TURTLE (*CHITRA INDICA*) IN BANGLADESH

(*With a text-figure*)

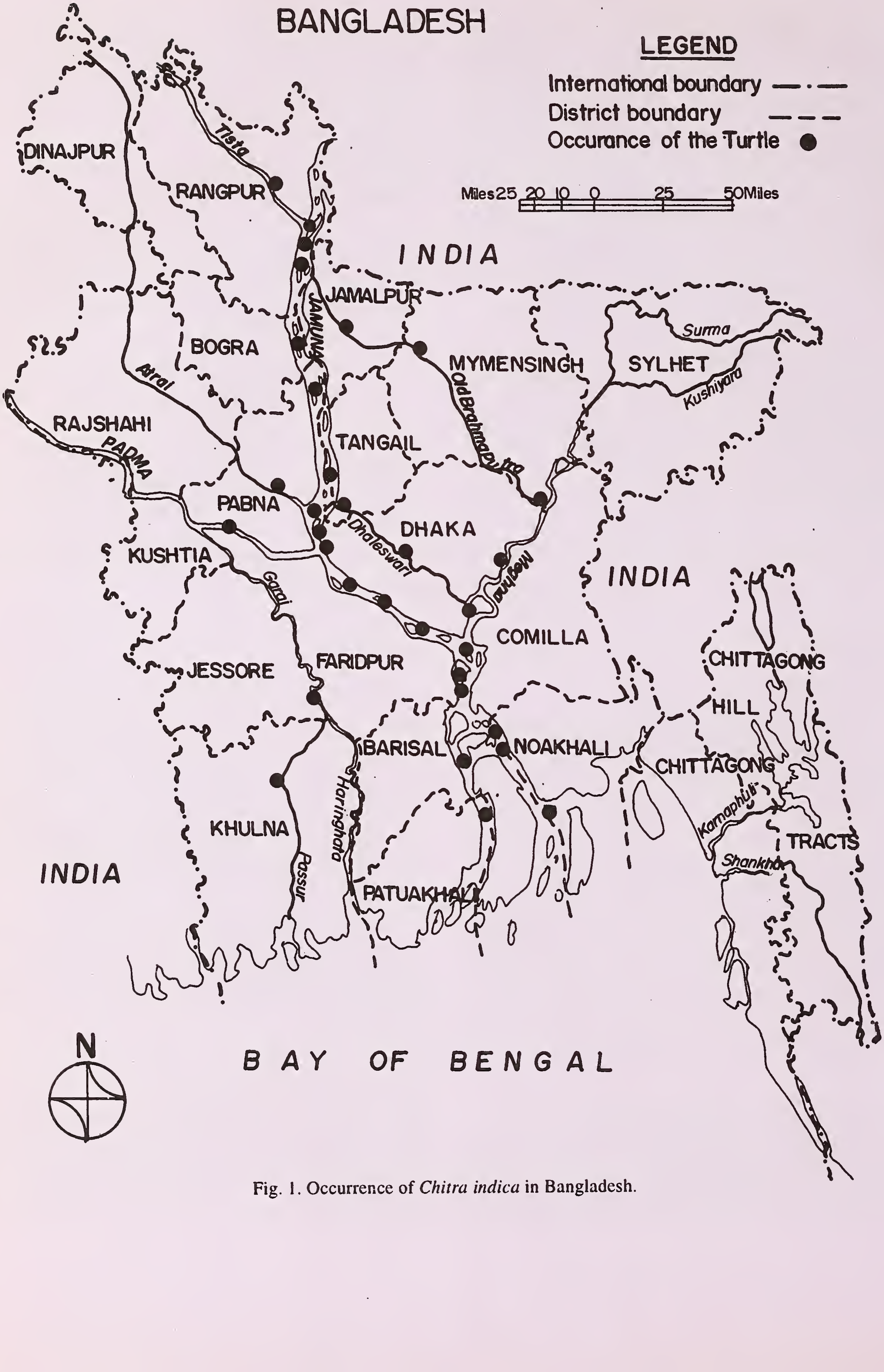
Introduction

Bangladesh is criss-crossed by a number of large rivers and tributaries, distributaries, canals, ditches, beels, ponds and marshy areas. About 9065 sq. km out of 143999 sq. km are flooded during the rainy season in each year. Turtles are consumed by Hindus and tribals as a source of protein (Rao 1986). Turtle eggs, oil, dry shell, meat, living and frozen specimens were exported to Japan, Hongkong, Malaysia, Thailand, Korea, China, United Kingdom, etc. About Tk. 2,41,18,272 was earned per year from 1973-1993 by exporting live turtles (Export Promotion Bureau of Bangladesh, 1972-1973 to 1992-1993).

Materials and Methods

The present study was conducted between August 1987 and December 1990 by direct observation in the field, turtle supply centers (for export), and turtle markets in different districts of the country. About 200 turtle catchers and collectors of different districts of the country were interviewed to ascertain the abundance and their habitat. Spear, fishing hooks, harpoons and jute sacks were used to catch and carry the turtles. Weight, length and breadth of total 45 (17 males and 28 females) specimens were measured.

Three turtle specimens were collected and reared in a jar, a concrete well and a mini pond in the Zoo of Department of Zoology, University of Dhaka for observing feeding behaviour. Food consumption was calculated by analysing the stomach contents of six freshly collected turtles. Metal tape, electronic balance and polythene bags were used to measure the turtle and consumed food. Food consumption was calculated by supplying known amount of food and subtracting the weight of uneaten food.


BANGLADESH
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JAMUNA
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Surma
Kushiyara
Old Brahmaputra
Atrai
RAJSHAHI
PADMA
TANGAIL
PABNA
DHAKA
Dhaleswari
Meghna
KUSHTIA
Garai
INDIA
COMILLA
CHITTAGONG
HILL
TRACTS
JESSORE
FARIDPUR
BARISAL
NOAKHALI
CHITTAGONG
Karnaphuli
Shankha
KHULNA
Haringhata
Passur
PATUAKHALI
INDIA
BAY OF BENGAL
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Fig. 1. Occurrence of *Chitra indica* in Bangladesh.

RESULTS AND DISCUSSION

Status and distribution: *Chitra indica* is a rare species in Bangladesh. It occurs in the major rivers of the country such as the Padma, Meghna, Jamuna, Brahmaputra, Bhairab, Sittalakkha, Buriganga, Tista, Kittankhola, etc. It is rarely found in their tributaries and distributaries. It is found in the Padma flowing through the districts of Rajshahi, Pabna, Kushtia, Faridpur, Rajbari, Manikganj, Munshiganj and Sariatpur. In the Meghna it is found near Chandpur, Bhola, near Sylhet and Kishoregonj districts; in the Jamuna at Kurigram, Bogra, Jamalpur and Serajganj districts. It was frequently found near Mohonpur and Aklashpur in the Chandpur district, Hisla, Bamabad, Golachipa in Patuakhali district (Fig. 1). Khan (1982) reported that *Chitra indica* is common, Sarker and Sarker (1988) noted that it is fairly common in Bangladesh, Khan (1982) found that it was distributed over the Padma and Jamuna river systems and their distributaries.

Measurements: Mean weight of adult males was 15.338 ± 1.75 kg (SD) (range 10-19.2 kg) while females were 23.305 ± 7.61 kg (range 10-55 kg).

Mean carapace length of adult males was 546.25 ± 27.9 mm (range 455-590 mm), of females 589.67 ± 59.7 mm (range 455-776 mm). Carapace width of males was 496 ± 18.37 mm (range 442-530 mm), of females 509.58 ± 29.02 mm (range 442 -579 mm).

Mean plastron length of males was 423.38 ± 14.2 mm (range 390-430 mm), and that of females was 445.42 ± 20.2 mm (range 398-508 mm). The average width of plastron of males was 486 ± 18.91 mm (range 440-490 mm), and that of females was 510 ± 18.88 mm (range 442-583 mm). The carapace length of *Chitra indica* was 168 mm and width 184 mm (Parshad 1914). Smith (1931) recorded the length of the disc at about 800 mm as also Daniel (1983). Shafi and Quddus (1976) recorded that the weight of the turtle may reach 265 kg, but did not mention sex and size.

Food consumption: The turtle is entirely carnivorous. Stomach contents of six specimens contained vertebrate and invertebrate remains, including molluscs, fish muscles and bone, intestine of animals, carcasses, crabs and prawns. Mean weight of the dissected turtles was 16.55 ± 5.59 kg and average food consumption was 171.67 ± 66.55 gm. Total consumed food was 1030 gm. Among the total food contents molluscs were 471 gm (45.73%), fish and fish bone 333 gm (32.33%), crustaceans 96 gm (9.32%) and carcasses 130 gm (12.62%). Among the consumed food molluscs (*Pila globosa, Unio bengalensis, Achatina fulica,* etc.) were the most frequent, and daily consumption was 78.5 ± 34.5 gm (0.48% of body weight). Crustaceans (*Macrobrachium* spp., *Portunus* spp., etc.) were the rarest food item, 24 ± 13.03 gm per day and 0.15%

TABLE 1
FOOD CONSUMPTION OF *Chitra indica*

Body weight (Kg)	Food items	Frequency	Range of consumed food (gm)	A*	B*
10.20-25.35	Molluscs (shells and flesh of *Pila, Unio, Achatina, Bellamya* spp.)	471	27-124	7850	45.73
	Fish (flesh, scale, bone of different fish)	333	22-132	5550	32.33
	Carcasses (intestine and fragments of animal)	130	12-84	2166.67	12.62
	Crustaceans (Prawns and crab)	96	12-46	1600	9.32

A*: Percentage calculated in relation to total number of dissected animals.
B*: Percentage calculated in relation to total amount of food contents.

of the body weight. Fish constitute 55.5 ± 37.46 gm and represented 0.34% of the body weight and carcasses were 43.33 ± 30.13 gm or 0.26% of the body weight (Table 1).

June 14, 1995

MD. LOKMAN HOSSAIN
MD. SOHRAB UDDIN SARKER
Department of Zoology,
University of Dhaka, Bangladesh.

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22. THE ASSAM ROOFED TURTLE *KACHUGA SYLHETENSIS* IN SADIYA — A NEW LOCALITY RECORD

On 26 March, 1994, a live specimen of Assam Roofed Turtle (*Kachuga sylhetensis*) was presented to me at Chapakhowa, the Headquarters of Sadiya Sub-division of Tinsukia district in far eastern Assam. It was collected by a fisherman from the Kundil River, north-east of Chapakhowa town, near Kundi Kaliya Reserve Forest. The location is not far from Assam-Arunachal Pradesh interstate border (only 4 km away). The turtle measured: SCL (Straight Carapace Length) — 90.6 mm (82.0 mm plastron), SCW (width) — 69.6 mm and (shell height) — 50.3 mm (measured with a Vernier Calliper). Subsequently the turtle was released in Dibru-Saikhowa Wildlife Sanctuary on 30 March, 1994.

The location from where it was collected is *c.* 95° 50' E. The known easternmost limit was Banko beel of Dibru-Saikhowa Sanctuary, which is at 95° 20' E longitude (Choudhury 1993: Hamadryad). This is thus the new easternmost locality for the Assam roofed turtle and also the first record from trans-Brahmaputra river.

I thank Sonowal, Junior Engineer of Sadiya Development Block for collecting the specimen for me.

December 30, 1994

ANWARUDDIN CHOUDHURY
Near Gate No. 1 of Nehru Stadium,
Islampur Road, Guwahati-781 007, Assam.

23. A COMMON GARDEN LIZARD (*CALOTES VERSICOLOR*) KILLING AN ADULT HOUSE SPARROW (*PASSER DOMESTICUS*)

On 8th March 1995, while walking my dog along a footpath at Bangur Nagar, Goregaon at around 1750 I saw a Fig tree *Ficus glomerata* full of figs and many black ants moving on the branches, and on the ants a common garden lizard was feeding. An adult male house sparrow was also busy feeding on the ants some 30 cm away from the lizard.

Suddenly the lizard ran towards the feeding sparrow and caught it by the neck. The sparrow with beating wings tried to escape from the lizard's jaw but did not succeed. As I moved closer, the lizard ran up the tree with its prey and disappeared.

June 12, 1995

V.K. PARALKAR
Manav Kalyan Society,
B2/3, Bangur Nagar,
Goregaon (West),
Bombay-400 090.

24. FIRST RECORD OF *UPERODON GLOBULOSUM* (ANURA: MICROHYLIDAE) FROM KERALA

The amphibian fauna of Kerala comprises of 86 species (Andrews and Sanil in press). The present record of a species of *Uperodon* from Kerala constitutes a further addition to the faunal wealth of the state.

Uperodon globulosum (Gunther, 1864)

A male of the species was collected from Manimala River at Erumely near Koratty bridge (72 m above msl), Kottayam District of Kerala during the month of July, 1994, while it was floating down the river, it had a snout to vent length of 67 mm.

U. globulosum is uncommon and its distribution was hitherto thought to be confined to W. Bengal, Orissa, Madhya Pradesh, Gujarat, Maharashtra and Karnataka (Inger and Dutta 1986). According to Daniel (1963), the genus *Uperodon* is endemic to India. Two species are so far reported of which *U. systoma* was reported from Kerala earlier by Inger and Dutta (1986). They are completely fossorial and are not seen above ground except during the breeding season.

The specimen has been deposited with the Zoology Museum of St. Thomas College, Kozhencherry, Kerala.

We are grateful to R.S. Pillai, Rtd. Joint Director, Zoological Survey of India, Madras for the identification of the specimen and assistance in the prepartion of the manuscript.

June 24, 1995

SANIL GEORGE
RG-CDEST,
Trivandrum-10, Kerala.
LEELAMMA ALEX
Dept. of Zoology, St. Thomas College,
Kozhencherry, Kerala.

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25. EXTENSION OF RANGE OF *NOEMACHEILUS (MESONOEMACHEILUS) PETRUBANARESCUI* (MENON)

Menon, A.G.K. (1984, *Cybium 8(2)*: 45-49) described a new species of loach, *Noemacheilus petrubanarescui* from Netravati river at Dharmasthala, Karnataka State, south India. He found zoogeographical significance due to the close resemblance of this species to *N. reticulofasciatus* of North Eastern India and suggested a common ancestry. There is no further report of its occurrence elsewhere.

While conducting a survey of freshwater fishes in Wynaad Wildlife Sanctuary, we collected five specimens of the species from Nulpuzha, a tributary of Kabani passing through Muthanga, thirteen kilometres away from Sultan's Battery. The morphometric and meristic characters are the same as those given in the original description except for some minor differences. The morphometric and meristic characters are described below.

D:3/8; A:2/5; P:1/10; V:1/7. Lateral line almost complete extending to the tip of the anal fin. Depth of body 5.5-6.6 times and length of head 3.8 times of standard length. Snout length 3 times and inter-orbital width 4.5 times in head length. Dorsal fin inserted equidistant in between the tip of the snout and the base of the caudal peduncle. Nostrils closer to the eye than to the tip of the snout. Barbels three pairs, the maxillary being the longest reaching the anterior one-third of the orbit. Body covered with embedded scales except on the ventral side.

The body has seven dark brownish bands. These bands split above the lateral line and extend slightly to the lower side of the lateral line. Ground colour is yellowish. A row of dark spots is present on the dorsal fin and two rows on the caudal fin. A rectangular black patch is present in the middle of the base of the caudal fin. The black dot at the origin of the dorsal fin is absent in these specimens.

The present collection extends the range of the species to the north of Palghat gap.

February 3, 1995

C.P. SHAJI
P.S. EASA
Division of Wildlife Biology,
Kerala Forest Research Institute,
Peechi-680 653,
Thrissur Dist, Kerala.

26. *PUNTIUS MELANAMPYX* (DAY), AN ADDITION TO THE FISH FAUNA OF SILENT VALLEY

The Silent Valley National Park is situated in Palghat district of Kerala (between lat. 11° 4' — 11° 14' North and long. 76° 24' — 76° 29' East). It is drained by the westward flowing Kunthipuzha joining the river Bharathapuzha. Ramadevi and Indra (1986, *Rec. Zool. Surv. India 84*: 243-257) listed nine species of fishes from Silent Valley. However, *Puntius melanampyx* (Day) has not been included in the list of species reported from there. Recently, a survey was conducted in Silent Valley. Twelve specimens of *P. malanampyx* (Day) were collected from a tributary of Kunthipuzha passing through Neelikal area of Silent Valley. This species was not found in any other tributary of Kunthipuzha. With the present collection of *P. malanampyx* (Day), the number of fish species in Silent Valley has risen to ten.

February 3, 1995

P.S. EASA
C.P. SHAJI
Division of Wildlife Biology,
Kerala Forest Research Institute,
Peechi-680 653, Thrissur Dist., Kerala.

27. FAMILY APHIDIDAE IS IN HEMIPTERA OR HYMENOPTERA?

While reviewing the book 'Animal Resources of India', I pointed out an error therein, showing the family Aphididae (or subfamily Aphidinae) in two insect orders, Hemiptera as well as Hymenoptera (Varshney and Gupta 1992).

The family name Aphididae in Hemiptera (Suborder Homoptera) is formed on the type-genus *Aphis* Linnaeus. Aphids are an economically important group of insects. The family name 'Aphididae' has been used for the aphids in many publications, e.g. Ghosh, A.K. (1975) and Ghosh, L.K. (1986). However, some authors have given the name as 'Aphidae', e.g. Beeson (1961).

The family name Aphididae in Hymenoptera is formed on the type-genus *Aphidius* Nees, under the superfamily Ichneumonoidea, but it is generally treated as 'subfamily Aphidinae' under the family Braconidae. Braconid wasps are important insect parasitoids, which have sometimes aphids as their primary hosts and thus, useful in their biological control. Family-group names 'Aphididae' and Aphidinae' in Hymenoptera have been used by some workers, e.g. Ray (1991). Marsh (1979) has also treated this group as a family in the 'Catalogue of Hymenoptera in America', but with a different spelling as 'Aphidiidae'.

Under the laws for the formation of family-group names (I.C.Z.N. 1985) the name of a family is to be based on its type-genus with the suffix '-idae' put uniformly. Thus, the family-group name based on *Aphidius* shall be Aphidiidae (Hymenoptera). The name based on *Aphis* ought to be 'Aphidae', based on the stem "Aphi-", but on account of the latin genitive, the stem shall be "Aphidis-" and it is fit to be called family Aphididae (Hemiptera). Hence, there must be clear difference of one letter, 'i' and 'ii', in the above two families of two separate insect orders.

However, it may be pointed out that family name Pieridae (Lepidoptera) based on type-genus '*Pieris*', was not changed to Pierididae, by use of plenary powers of the I.C.Z.N. (Hemming 1956), as done for Aphidae above.

It may also be pointed out that a similar case exists between family 'Tachinidae' Fleming, 1821 in Coleoptera, and family 'Tachinidae' Robineau-Desvoidy, 1830 in Diptera.

ACKNOWLEDGEMENT

Thanks are accorded to the Director, Zoological Survey of India, for encouragement.

January 5, 1995 R.K. VARSHNEY
Zoological Survey of India,
Calcutta-700 053.

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28. OCCURRENCE OF *MORGANELLA CUEREONSIS* (COCKERELL) (DIASPIDIDAE: COCCOIDAE: HOMOPTERA) IN SOUTH INDIA

Leucas aspera is a wildly growing garden and dry land weed. It is infested by a variety of armoured scales like *Aspidiotus destructor* Signoret, *Morganella longispina* (Morgan), etc., in large numbers. During the survey conducted between 1989-1993, the presence of another species *M. cuereonsis* (Cockerell) was discovered on this host.

The scale of female is oval to circular in shape, grey coloured, with exuviae, at the anterior end. The adult female is oval to pyriform in shape, 2.22-3.00 mm long and 2.22-2.30 mm wide. Pygidium broad and rounded apically with a pair of median lobes only with an apical notch on the outer margin, well sclerotised with basal sclerosis which extends to the pygidium. Scleroses between sixth and seventh and seventh and eighth segments well developed. Space between the lobes very narrow and appears to be parallel. Second and third lobes lacking. Plates adjacent to median lobe three in number, fringed only at their tip. A seta also present apart from the lobes. Ducts I-barred, present along the margin and also medially. Duct orificies arranged into submedian and median races. Anus situated within posterior one-fourth distance from the pygidial tip. Vulva present just above the anus. Perivulvar pores absent. Dorsal paraphyses elongate and forked at its tip. Microducts only along the margin. Antenna with a long seta and three small spurs. Spiracles without disc pores. This scale infests the stem, petiole, leaves and even roots. A maximum of 120 insects was observed on a stem of 5 sq. cm and on a single leaf a maximum of 22 insects were observed. Affected plants turn yellow and dry away. This species was first described by Cockerell and redescribed by Ferris (1955) and recorded on *Celtis* sp., *Fagaria fagaria, Acacia flexicaulis* and *Magnolia* sp. Earlier another species *M. longispina* has been recorded on citrus (Pruthi and Mani 1945). However, *M. cuereonsis* can be differentiated by the small sized anal opening located slightly away from the apex and the plates being comparatively narrower and fewer than *M. longispina.*

The species is being recorded for the first time in India.

March 7, 1995

S. SURESH
M. MOHANA SUNDARAM
Department of Agricultural Economics,
Centre for Plant Protection Studies,
Tamil Nadu Agricultural University,
Coimbatore-641 003.

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29. NOTES ON THE BIOLOGY OF *PIERIS BRASSICAE* (LINNAEUS) (PIERIDAE: LEPIDOPTERA) ON A NEW HOST PLANT *CASSIA FISTULA* (CAESALPINIACEAE)

Pieris brassicae (Linn.) is a polyphagous pest infesting a wide variety of Cruciferae, besides feeding on some other food plant (Feltwell 1982). Recently it was found to feed on *Cassia fistula* (Amaltas) grown in the Punjabi University, Patiala.

Scanning of literature reveals this to be a new host plant infested by larvae of *P. brassicae.* Observations were made on certain biological aspects of the species. For oviposition tender leaves of 'Amaltas' were preferred and the eggs were laid either singly or in groups. In addition some eggs were noticed on older/mature leaves. The time interval between egg laying was 3 to 5 seconds duration. They hatched between 3 to 5 days and the larvae eat the egg shell on their way out. The larval duration of each instar was 4+1 days and consumed 405+245.14 mgs, 556.5+311.937 mgs, 618.5+300.937 mgs and 751.5+381.737 mgs during I, II, III, IV instars per larva per day respectively. The pupal period was 5+1 days. The life cycle was completed in 32+5 days including adult life span of 10+3 days on the presently reported host plant under controlled condition (temperature 22°C, RH 40-70%, photoperiod 12 hrs light and 12 hrs dark, observations were made between 8.5.1991 to 11.6.1991).

Eclosion in *P. brassicae* has been reported to be facilitated by pneumatic pressure (Cottrell 1964) and irregular jerks of the imaginal abdomen (Nicolson 1976). However, we have observed that besides pneumatic pressure, the eclosion also involves mechanical pressure exerted by outward curling of the imaginal wings. Therefore, the eclosion is Pneumato-mechanical.

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January 5, 1995

H.S. ROSE
G. VENKATESH
Department of Zoology,
Punjabi University,
Patiala 147 002 (Pb.).

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30. A NEW ALTERNATIVE HOST PLANT OF TEAK DEFOLIATOR *HYBLAEA PUERA* (HYBLAEIDAE : LEPIDOPTERA)

The *Hyblaea puera* is one of the most important pests of teak and is widely distributed in the tropical habitat of Oriental and Australian region. In September 1979, while travelling by suburban train, it was noticed that mangrove vegetation of the Mahim creek area, except a few had turned brown and several House and Jungle Crows and Cattle Egrets were pecking on branches to eat something. Subsequently I visited the Mahim Creek area and observed that most of the leaves of mangrove *Avicennia marina* Vierh. were dried and curled and had turned brown. When some of the curled leaves were opened, it was found that the leaf was skeletonised and had a pupa. The jungle and house crows and cattle egrets were pecking the dried leaves to feed on pupae.

The samples so collected were brought to the laboratory and kept in a jar. After 3 days the pupae hatched and moths emerged, which were identified as *Hyblaea puera.*

In January 1995 again a similar incident was noticed by Mr. Vivek Kulkarni, incharge of mangroves at Godrej land, Bombay. The species affected was *Avicennia marina.* On my request he sent a few sample of the affected leaves. However, this time most of the pupal skeletonised leaves contained empty pupal cases, a few leaves having intact pupae. The moth which emerged from the pupa was identified as *Hyblaea puera.*

According to Beeson (1941), Mathur (1960) and Mohandas (1986) most of the alternate host plants belong to family Verbenaceae, Bignoniaceae, Areliaceae, Juglandaceae and Oleaceae.

Avicennia marina, earlier classified under family Verbenaceae, is now placed under a separate family Avicenniaceae. While going through the chemical composition of these plants it was noted that both the plants, i.e. *Tectona grandis* and *Avicennia marina* have tannin. However, the concentration of tannin varies in different parts of the plants.

July 22, 1995

NARESH CHATURVEDI
Bombay Natural History Society,
Hornbill House, Dr. Sálim Ali Chowk,
Shaheed Bhagat Singh Road,
Bombay-400 023.

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31. OCCURRENCE OF *AGAUOPSIS BREVIPALPUS BREVIPALPUS* TROUESSART (HALACARIDAE: ACARI) FROM WEST COAST OF INDIA

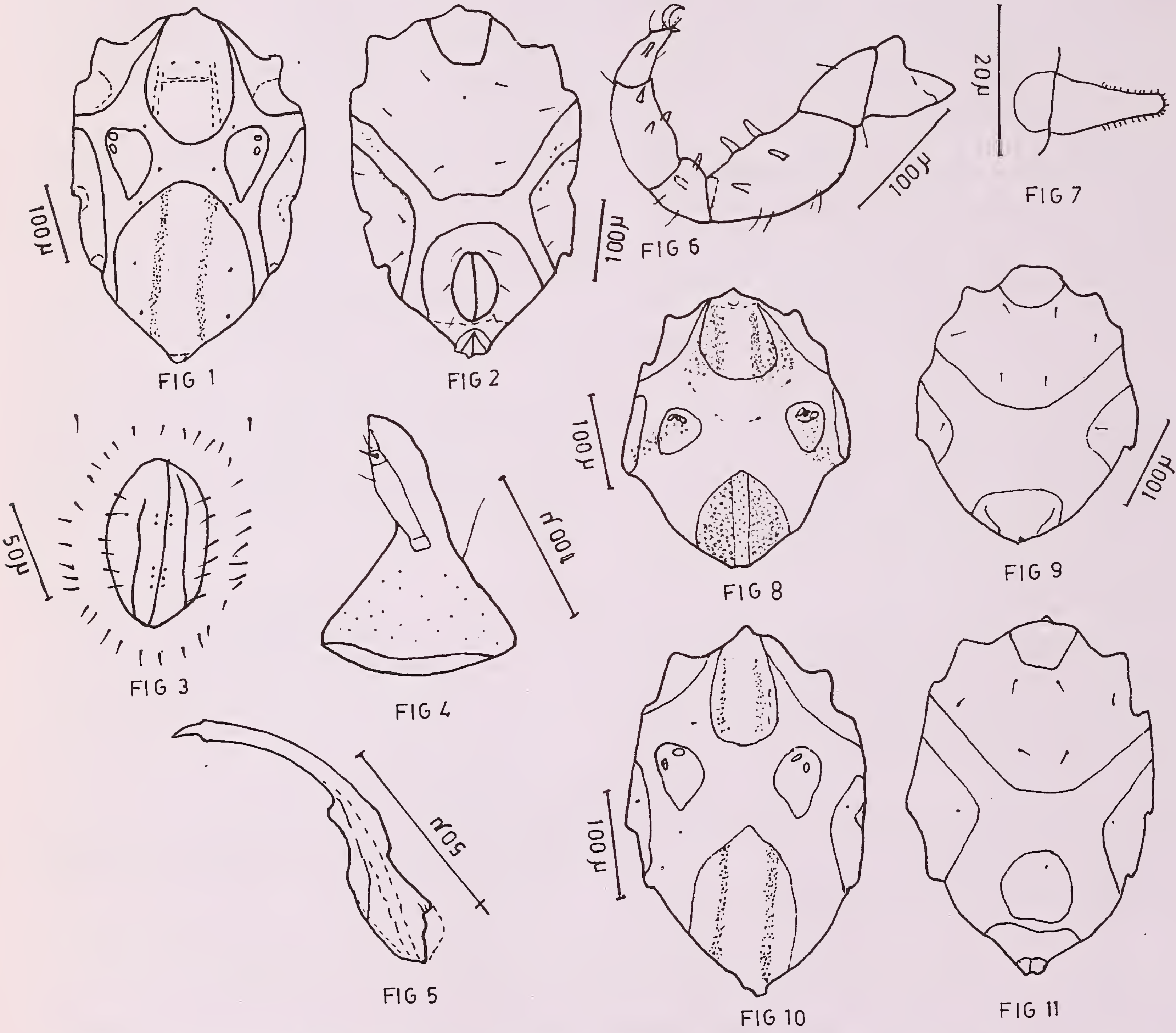
(*With eleven text-figures*)

The systematics of halacarids of the west coast of India of late have been researched by me, resulting in the reporting of *Copidognathus sideus* Bartsch, 1982 and *Arhodeoporus bonairensis* (Viets, 1936) from the phytal realm of Cochin backwater and Kovalam beach respectively (Chatterjee and Sarma 1993, Sarma and Chatterjee, in press).

In the present communication, *Agauopsis brevipalpus brevipalpus* Trouessart is reported for the first time from west coast of India. A number of male, female, larval and nymph specimens were encountered on different algal species from Kovalam beach, Kerala, west coast of India. Rao and Ganapati (1968) mentioned this species in the list of interstitial fauna of Waltair coast (east coast of India, Bay of Bengal).

A brief description of the species is given below.

FEMALE: Idiosomal length of females ranged between 400 μ and 500 μ. All dorsal plates are separate (Fig. 1). Anterodorsal plate (AD) bears a unidentate frontal margin and a raised H shaped areola. The dorsal seta 1 (ds_1) lies in the anterior half of AD. The dorsal setae 2, 3 and 4 (ds_2, ds_3 and



Figs. 1-11. *Agauopsis brevipalpus brevipalpus* Trouessart: 1. Idiosoma (dorsal) of female; 2. Idiosoma (ventral) of female; 3. Genital area of male; 4. Gnathosoma; 5. Chelicera; 6. Leg I; Fig. 7. Magnified view of ventral seta of telofemur I; 8. Idiosoma (dorsal) of larva; 9. Idiosoma (ventral) of larva; 10. Idiosoma (dorsal) of protonymph; 11. Idiosoma (ventral) of protonymph.

ds_4) are present on the membranous area. The dorsal setae 5 (ds_5) are on posterodorsal plate (PD). The PD bears two costae divergent anteriorly.

All ventral plates are separate (Fig. 2). Anterior epimeral plate (AE) with 3 pairs of setae. Posterior epimeral plate (PE) with 3 ventral and 1 dorsal seta. Three pairs of perigenital setae (PGS) are present around the genital opening (GO).

Rostrum approximately equal in length to the palp. Palp 4-segmented (Fig. 4). Palpal trochanter without any seta. Palpal femur with one dorsal seta. Palpal patella has one spiniform anterior seta. Palpal tibiotarsus bears one dorsal and one ventral seta at the base.

Leg I is stronger than other legs. Telofemur I with 4 dorsal hair-like setae and 4 stout setae (Figs. 6, 7). Patella I with 4 setae, of which 2 are spiniform. Tibia II with 3 spiniform setae. Tibiae III and IV with 2 spiniform setae. All legs with two lateral claws. Lateral claw I without any pecten or accessory process. Lateral claws II-IV with an accessory process dorsally and faintly pectinate ventrally.

MALE: The idiosomal length of males ranged between 400 μ and 500 μ. Males are similar to the females in all characteristics except for the GA region, where the perigenital setae are arranged in two rings containing 40-60 setae (Fig. 3). Five pairs of subgenital setae (2 anteriorly, 3 posteriorly) are present on the sclerites of GO. The cuticular membranous zones between the idiosomal plates are less wide in male than in female.

Larvae: The idiosomal length of larvae ranged between 220 μ and 240 μ. All dorsal plates of larvae are smaller than those of nymphs or adults (Figs. 8, 9). A large cuticular membranous area is present between different plates.

The dorsal seta 1 lies on anterodorsal plate; dorsal setae 2, 3 and 4 on membranous area on posterodorsal plate. All ventral plates are separate. The genital foramen is absent. Two pairs of setae are present on AE and one pair on PE. Genital acetabulae are not present on the genital plate. There are 3 legs bearing 5 segments each.

Protonymph: The idiosomal length of protonymph ranged between 260 μ and 300 μ. All dorsal plates are separate and smaller than those of deutonymph or adult (Figs. 10, 11). Dorsal chaetotaxy is same as that of the larvae. AE with 3 pairs of setae and a pair of genital acetabulae. Genital foramen is absent. First three pairs of legs with 6 segments and the 4th leg with 5 segments.

Deutonymph: The idiosomal length of deutonymph measured 350 μ to 375 μ. Deutonymph differs from the protonymph in that three pairs of genital acetabulae and all the 4 legs bear 6 segments in the former.

Distribution: This species is known from Atlantic coasts of Europe, Bermuda, North America, South America, Africa, Black Sea, Bay of Bengal, Australia (Trouessart 1889 a, b, 1901; Lohmann 1893, 1901; Andre 1928, 1929, 1942, 1946; Viets 1936, Newell 1947, Rao and Ganapati 1968, Rao 1972, Bartsch 1975, 1976 a, b; Schuster and Bartsch 1986, Green and Macquitty 1987), and west coast of India (present report).

The species is found among Algae, Bryozoa, Holothuria, on mud and occasionally in sediment in the intertidal and subtidal zones down to 1220 metres.

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March 7, 1995 TAPAS CHATTERJEE
Dept. of Biology, Indian School of Learning,
Indian School of Mines Annexe,
Dhanbad-826 004, Bihar.

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32. OCCURRENCE OF THE SNAIL *PHYSA ACUTA* DRAPARNAUD IN CALCUTTA, INDIA

Physa acuta, the freshwater Basommatophoran gastropod snails of the family Physidae are represented by fossil forms in India (Subba Rao 1989, Handbook: Freshwater Mollusca of India, Z.S.I.). But recently, in the course of our studies on freshwater molluscs of Calcutta and adjacent areas we had the opportunity to collect some examples of the snail species from a narrow drain containing domestic sewage, by the side of B.T. Road, Dunlop (near Indian Statistical Institute), Calcutta. The major part of the drain was occupied by mud mixed with household refuse. There was a little water in the mud of the drain. *Oscillatoria* sp., *Euglena* sp. and *Navicula* sp. were very common in these waters. A good number of individuals belonging to *P. acuta* and *Lymnaea* (*Radix*) *luteola* (Lymnaeidae: Gastropoda) were seen moving in the water. At a glance it was not possible to distinguish *P. acuta* from *L.* (*R.*) *luteola*, but by careful observations, differences in characteristics of the shells were noted and the occurrence of two types of snails in the same habitat was confirmed. Some specimens, bearing shells different from those of *L.* (*R.*) *luteola* shells were submitted to the Malacological Division, Zoological Survey of India, Calcutta for identification. They were identified as *Physa acuta* Draparnaud (ZSI, Lot No. Moll. 843, I.R. No. 15/94). Though existence of *P. acuta* in Pakistan is on record its occurrence in India is being reported for the first time.

We thank the Head of the Department of Zoology, Calcutta University, Calcutta for the facilities provided. Thanks are also due to Shri K.V. Surya Rao, Deputy Director, Zoological Survey of India, Calcutta for identification of the snail specimens.

March 8, 1995

S. K. RAUT
SONALI BHAUMIK
SUBHAMOY DAS
Ecology and Ethology Laboratory,
Department of Zoology, University of Calcutta,
35, B.C. Road, Calcutta-700 019.

33. RARE OCCURRENCE OF MULTIPLE LEAFY BUDS IN CABBAGE, *BRASSICA OLERACEA* VAR. *CAPITATA* LINN.

(*With a text-figure*)

Brassica oleracea var. *capitata* Linn. (Brassicaceae) is of European origin which was introduced and cultivated in some parts of India for its terminal leafy buds as a leaf vegetable. The thick and short stemmed herbaceous plants of this taxon generally produce a single massive terminal bud which is sometimes even larger than a human head.

During a recent visit to the local vegetable market I came across a vendor who happened to receive a consignment from Ooty containing the presently reported specimen (Fig. 1) with five terminal leafy buds (one large and four small) on single shoot which phenomenon is rare under natural conditions. I am not aware of any such report in the literature. It is worth considering that such abnormal growth of multiple terminal leafy buds from a single plant either naturally or by artificial induction may be economically exploited to the advantage of both farmers and consumers.

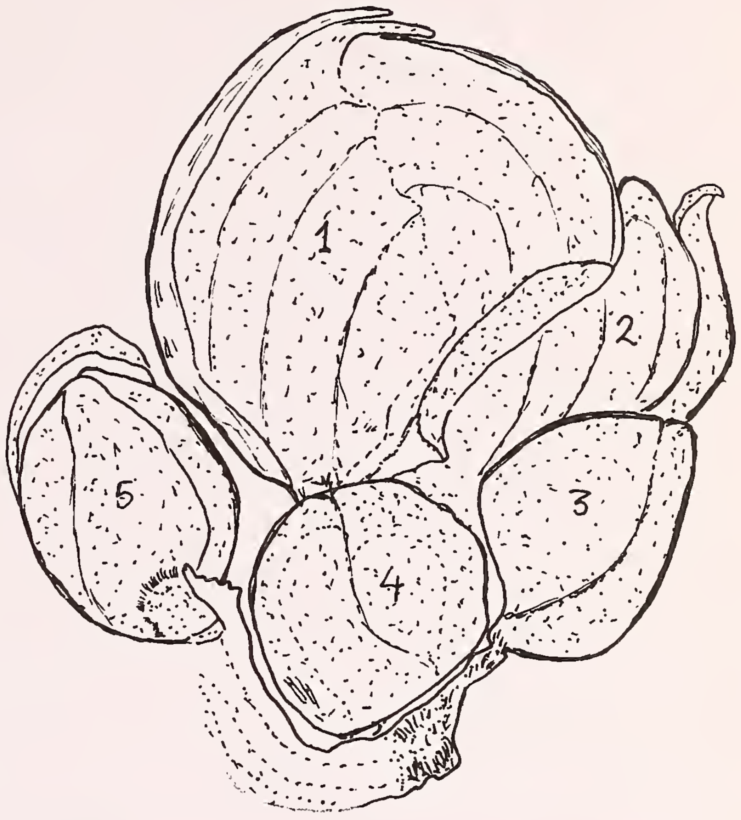

Fig. 1: Multiple terminal leafy buds in cabbage

I thank Dr. P.K. Hajra, Director, Botanical Survey of India, Calcutta for encouragement and to Dr. P.M. Padhye, Scientist-SD-In-charge for facilities.

August 16, 1994

P.S.N. RAO
Scientist 'SD', Botanical Survey of India,
Andaman & Nicobar Circle,
Port Blair-744 102.

34. *CASSIA UNIFLORA* MILL. VERSUS *PARTHENIUM HYSTEROPHORUS* L. — AN ECOLOGICAL STUDY

For the past few years we have been observing a competition between *Cassia uniflora* Mill. and *Parthenium hysterophorus* L. in Pune. Singh (1983) had reported that *C. uniflora* had been penetrating the areas traditionally occupied by *P. hysterophorus.*

A welcome aspect of *C. uniflora* is the presence of root nodules which may enrich the soil by nitrogen fixation. As such the invasion by *C. uniflora* on lands dominated by *P. hysterophorus* — which is known to cause allergic reactions in humans — may in fact prove beneficial, although *C. uniflora* too is also spreading like a weed.

In order to substantiate the claim of *P. hysterophorus* being suppressed by *C. uniflora,* we undertook a quantitative estimation of the two species using the Quadrat method (Michael 1986). Twenty-eight quadrats of 1 m x 1 m were laid on vacant lands and along roads to find out the comparative density of *C. uniflora* and *P. hysterophorus.* Table 1 gives details of the quantification.

From Table 1 it is evident that the number of *C.uniflora* (700) is much more than the number of *P. hysterophorus* (281).

We feel that more such quantitative studies

TABLE 1
COMPARATIVE DENSITY OF *C. uniflora* AND *P. hysterophorus*

	Site & Date	*C. uniflora* (no. of plants)	*P. hysterophorus* (no. of plants)
1.	Univ. of Poona Playground, 7.8.93	0	19
2.	-do-	7	5
3.	-do-	0	11
4.	-do-	37	9
5.	-do-	50	0
6.	Off Sinhagad Road, 8.8.93	41	8
7.	-do-	1	0
8.	-do-	1	0
9.	-do-	7	0
10.	-do-	42	0
11.	-do-	0	1
12.	-do-	82	0
13.	-do-	75	7
14.	-do-	110	10
15.	Off Pashan Road 9.8.93	24	12
16.	-do-	0	0
*17.	-do-	50	Abundant
18.	-do-	2	5
19.	Bavdhan Khurd 9.8.93	28	30
20.	NDA Square 9.8.93	56	0
21.	-do-	0	1
22.	-do-	2	6
23.	-do-	0	8
24.	Baner Road 11.8.93	26	18
25.	-do-	44	1
26.	-do-	3	3
27.	-do-	10	80
28.	-do-	2	47
	Total	700	281

* At this spot the proximity of *P.hysterophorus* did not permit counting of each individual.

must be carried out in various other places to determine the dominant nature of *C. uniflora.* Besides, comparative soil analysis of areas dominated by *C. uniflora* and those dominated by *P. hysterophorus* will help in deciding whether intentional introduction of *C. uniflora* in areas dominated by *P. hysterophorus* could be of help. Agronomists could probably throw more light on this aspect.

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January 5, 1995
G.K. WAGH
H.V. GHATE
Post-Graduate Research Centre,
Department of Zoology,
Modern College, Pune-411 005.

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35. *MEDICAGO LUPULINA* LINN. (LEGUMINOSAE) — A NEW RECORD FOR RAJASTHAN

(*With a text-figure*)

During one of the plant collection visits to tehsil Umrain, Alwar district (Rajasthan). I collected *Medicago lupulina* Linn. from the dry beds of Jaisamand lake and near-by fields. A perusal of the literature shows that this species has not been reported from Rajasthan (Dhillon and Bajwa 1969, Bhandari 1978, Sharma and Tiagi 1979). This paper records for the first time the occurrence of *Medicago lupulina* Linn. from Rajasthan. It is known so far from the plains of Punjab and Bengal and in the

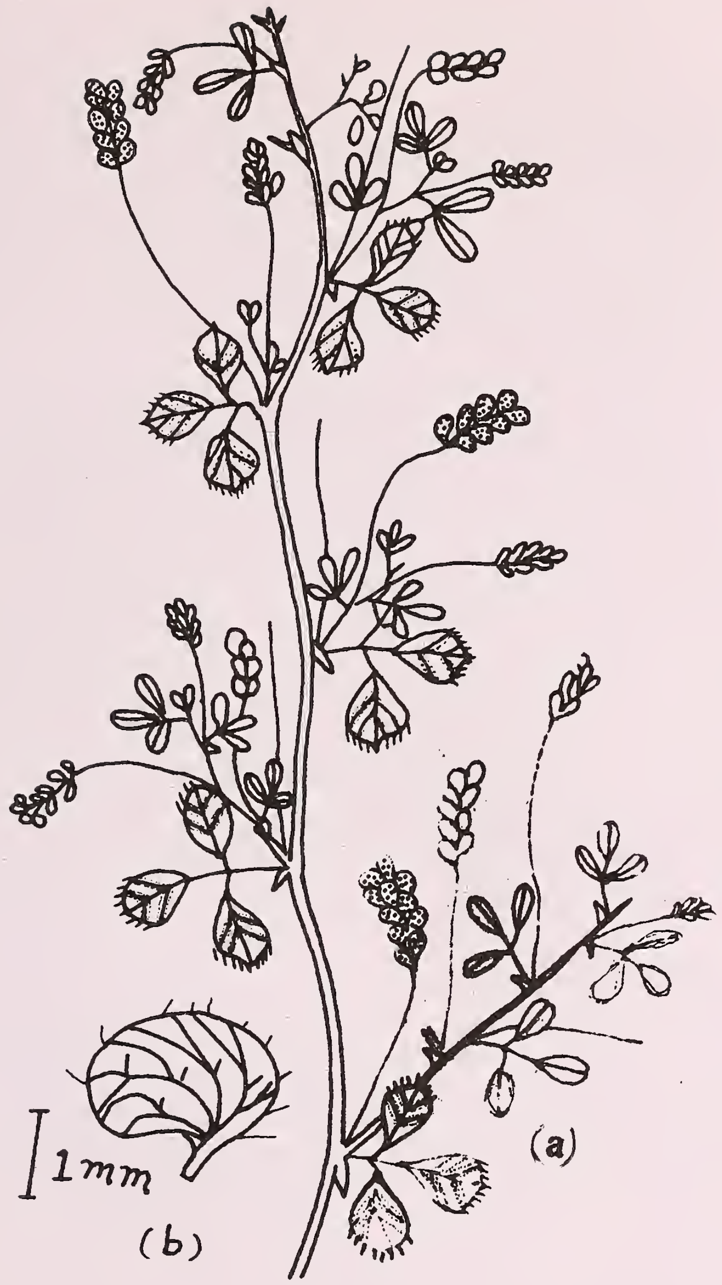

Fig. 1. *Medicago lupulina* Linn.
(a) a flowering branch; (b) a pod.

Himalayas up to 370 m altitude (Duthie 1960) and from Delhi (Maheshwari 1966). The specimens of *M. lupulina* collected from Umrain, Alwar district have been housed in the Herbarium of Post-Graduate Department of Botany, Raj Rishi College, Alwar.

Medicago lupulina Linn. Sp. Pl. 779. 1753; FBI. 2: 90. 1879; Duthie, Fl. Upp. Gang. Pl.B.S.I. reprint 1:194. 1960; Mansfeld in Die Kulturplanze Beih. 2:163. 1969. (Fig. 1).

A prostrate, biennial herb. Stem profusely branched, branches spreading in all directions from the base, branches up to 35 cm long, internodes long, angular, hairy. Leaves trifoliate, rachis grooved, hairy; stipules narrow, acute, hairy; Leaflets up to 10 x 9mm size, obovate, slightly dentate on the upper half, mucronate, sparsely hairy. Flower very small, yellow, in axillary racemes, aggregated on the upper part of the peduncle which are longer than the leaves, bracteate, bracteolate. Calyx companulate, teeth acute, persistent, hairy. Corolla slightly exserted. Pod small, 2 x 1 mm size, sickle-shaped, sparsely hairy, turgid, biconvex; veins prominent, forked and ending at the ridge; turn black on maturity, 1-seeded, indehiscent. Seed kidney shaped, yellow.

Specimens Examined: Jaisamand lake, Umrain, Alwar Distt., Rajasthan; Yadav-12, 13.

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A.S. YADAV
P.G. Department of Botany,
Raj Rishi Autonomous College,
Alwar-301001, Rajasthan.

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36. NOTE ON REVERSION OF INFLORESCENCE AXIS IN *CAESALPINIA CRISTA* L.

Flowering is an important event in the life of the plant, signalling its commitment to the development of fruits and later to seed development. Once the process of flower morphogenesis starts, it ends with this normal reproductive phenomenon. However, in rare instances, flowering process reverses and the vegetative growth resumes instead of reproductive stage after flowering initiation. This type of reversion to vegetative growth is regarded as a teratoma (Guedes and Dupuy 1979).

Reversion of flowering in *Caesalpinia crista* L. was observed during field collection near Pune metropolitan area. Detailed laboratory observations are presented in this communication.

Samples of normal and abnormal flowering inflorescences in *Caesalpinia crista* L. were collected in the month of September 1991. Relevant observations on normal and teratological specimens were recorded using standard methods during the study. Observations were recorded in 8 inflorescence samples. Filiform structures are modifications of different floral organs like buds, sepals and petals. Different reversion types were recorded which is presented in Table 1.

Table 1

CHARACTERS OF REVERSION TYPES OBTAINED IN *Caesalpinia crista* L.

Reversion type	Characters exhibited by infected plants on single axis
R0	Reversion of calyx and corolla to leaves.
R1	Reversion in the form of leaf, filiform structures, pods, bracts, pedicels, buds and bracts.
R2	Leaves and filiform structures.
R3	Leafy bracts and pods.
R4	Bracts, buds, small fruits, anthers and filiform structures.

REVERSION OF INFLORESCENCE AXIS IN *Caesalpinia crista* L.

Sample	Reversion types															
No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I A	14	14	-	4	-	-	-	-	-	-	-	-	-	-	-	-
I B	18	48	1	3	20	-	2	-	1	-	-	-	-	-	-	-
II A	-	5	-	-	-	-	-	-	-	-	-	5	-	-	-	-
II B	5	1	-	-	-	-	-	-	-	-	-	4	-	-	-	-
II C	5	-	2	-	5	-	43	-	1	-	-	-	-	-	-	-
II D	2	20	-	-	6	-	52	-	-	-	-	-	8	-	-	-
III	14	9	-	-	4	3	32	11	-	1	-	-	6	-	-	-
IV A	5	-	1	-	25	-	-	11	-	1	-	-	6	-	-	-
IV B	-	-	-	-	8	-	-	44	-	-	-	-	-	-	-	-
V	15	-	1	-	-	-	-	-	-	-	-	2	-	11	-	-
VI A	-	2	-	-	-	-	-	-	-	-	-	-	-	-	10	-
VI B	-	-	-	-	-	-	-	4	-	-	30	-	-	-	-	4
VII A	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VII B	25	16	-	-	1	-	-	-	-	-	-	-	-	-	-	-
VIII	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Reversion types: 1. leaves; 2. filiform structures; 3. pods; 4. bracts; 5. pedicels; 6. buds and bracts; 7. leaves and filiform structures; 8. leaves and bracts; 9. leaves and pods; 10. bracts, buds, anthers, filiform structures & fruits; 11. bracts, buds and filiform structures; 12. fruits and filiform structures; 13. bracts, leaves and filiform structures; 14. bracts, leaves and buds; 15. buds and filiform structures; 16. bracts and filiform structures.

Reversion type	Characters exhibited by infected plants on single axis
R5	Small fruits and filiform structures together.
R6	Leafy bracts and filiform structures.
R7	Leaves and buds.
R8	Bracts, buds and filiform structures.
R9	Filiform structures and buds.

The phenomenon of reversion of flowering axis is attributed to some sort of imbalance in auxins. Rizwi (1980) mentions that fasciation is due to fungal diseases. Greene (1980) reports that fasciated plants grow slowly and bear abnormally small leaves, thickening of the internodes and a reduction in growth of main shoot. This natural phenomenon affects the development of fruits and seeds. This happens in plants due to the presence of bacteria living mostly on the exterior of the host plant. He has reported the bacterial species *Corynebacterium fascians* in *Pisum sativum* L. and *Agrobacterium tumefaciens* which causes crown gall disease in dicotyledonous plants. This type of symbiotic relationship between plant and micro-organism is really valuable for production of cytokinins. At present, plasmids of *Agrobacterium,* caulim viruses and gemini viruses have been used as potential vectors to carry out genetic transformations (Kumar and Kumar 1992). Isolation of such micro-organism from natural teratological resources will be useful in fields like genetic engineering.

ACKNOWLEDGEMENTS

We are thankful to Director, ARI for providing laboratory facilities and Shri V.N. Joshi for assistance.

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D.K. KULKARNI
M.S. KUMBHOJKAR
Botany Group, Division of Plant Science,
Agharkar Research Institute,
G.G. Agarkar Road, Pune 411 004.

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37. IDENTITY OF *PHYSALIS LONGIFOLIA* SENSU NAIR

Nair (In *Bombay nat. Hist. Soc. 59 (1)*: 323-324. 1962) recorded *Physalis longifolia* Nutt. from Kerala. Critical study of herbarium specimens and living materials and consultation of recent taxonomic literature revealed that the specimens identified as *P. longifolia* Nutt. by Nair belong to *Physalis angulata* Linn. We have collected this species from Tiruchirapalli and voucher specimens have been deposited in Southern Circle of Botanical Survey of India, Coimbatore (MH/160161-160165).

P. longifolia Nutt. is a rhizomatous species with angular stems, flowers having brownish centre and the anthers purple tinged. These characters are not seen in the specimens collected by Nair (Accession nos. 1156, 1158, 1161, 1164, Dehradun). In contrast they have strong tap-roots, hollow stems, pale brown maculations in corolla throat and blue tinged anthers typical of *P. angulata* Linn. In order to confirm the correct identity, herbarium specimens and the fresh materials were sent to Dr. Mahinda Martinez, a new world expert on systematics of genus *Physalis* Linn. in tropical America, who has kindly confirmed our identification.

ACKNOWLEDGEMENTS

We are grateful to Dr. Mahinda Martinez for identification of the specimens and to the C.S.I.R. for financial assistance to one of us (S.S.).

May 23, 1995

S. SUDHAKARAN
A. GANAPATHI
Department of Biotechnology,
School of Life-sciences,
Bharathidasan University,
Tiruchirapalli-620 024.

38. ADDITIONS TO THE SCROPHULARIACEAE OF GOA

The flora of Goa is relatively underexplored when compared to the neighbouring states, namely Karnataka and Maharashtra. This is true at least with regard to the seasonal plants, as in the case of the family Scrophulariaceae. The latest work on the region by Rao (Flora of Goa, Diu, Daman, Dadra and Nagarhaveli, 1985-86) records 32 species, out of which only 24 species (including three cultivated) are specifically reported from Goa, whereas 41 species are recorded for the adjacent Savantwadi area (Almeida 1990. The Flora of Savantwadi vol. I) for the family Scrophulariaceae. During our work on the Scrophulariaceae of Goa, we found that the following taxa have not been recorded from Goa by Rao (l.c.).

All the specimens examined are deposited in the herbarium, Department of Botany, Goa University.

1. **Buchnera hispida** Buch.-Ham. ex D.Don, Prodr. Fl. Nep. 91. 1825; Cooke, Fl. Bombay 2: 373. 1967 (repr. ed.).

An erect herb with bluish-pink corolla, growing up to 60 cm high. Grows on dry, laterite slopes amidst grasses during post monsoon season. The specimens dry black.

Fl. & Fr.: October-November.

Exsiccata: Goa, Verna plateau, 17.10.1993, Rupa 48.

2. **Limnophila aquatica** (Roxb.) Alston, Ann. Roy. Bot. Gard. Paradeniya 11:205. 1929; Cramer in Dassanayake & Fosberg, Rev. Handb. Fl. Ceylon 3: 431. 1981; Kulkarni, Fl. Sindhudurg 298. 1988. *Cyrilla aquatica* Roxb., Pl. Cor. 2: 47, t. 189. 1798. *Limnophila racemosa* Benth., Scroph. Ind. 26. 1835; Cooke, Fl. Bombay 2: 362. 1967 (repr. ed.).

A heterophyllous, aquatic herb; flowers in curved racemes. This distinct species is often treated conspecific with *L. indica* (L.) Druce. Cramer's (l.c.) treatment is followed here.

Fl. & Fr.: October-March.

Exsiccata: Goa, Pilar, 17.10.1993, Rupa 46.

3. **Limnophila repens** (Benth.) Benth. in DC., Prodr. 10: 387. 1846; Almeida, Fl. Savantwadi 1: 296. 1990. *Stemodia repens* Benth. in Edward's Bot. Reg. 17: sub t. 1470. Sp. 11. 1832. *Limnophila conferta* Benth. in DC., Prodr. 10: 387. 1846; Cooke, Fl. Bombay 2: 361. 1967 (repr. ed.).

An erect or prostrate herb. The absence of dissected leaves distinguishes this from the above species. Common in fallow fields during late and post monsoon.

Fl. & Fr.: September-January.

Exsiccata: Goa, Benaulim, 13.9.1993, Rupa 43, 45.

4. **Lindernia antipoda** (L.) Alston in Trimen, Handb. Fl. Ceylon 6 (Suppl.): 214. 1931; Philcox in Kew Bull. 17:484. 1964 & 22: 57. 1968; Sivarajan & Mathew in J. Bombay nat. Hist. Soc. 80: 133. 1983; Almeida, Fl. Savantwadi 1: 299. 1990. *Ruellia antipoda* L., Sp. Pl. 635. 1753.

A prostrate herb; common in marshy or wet situations. Though there is no reference to this species by Rao (l.c.), the synonyms of this species, namely *Bonnaya veronicaefolia* and *Ilysanthes veronicaefolia* are cited under *Lindernia anagallis.*

Fl. & Fr.: July-January.

Exsiccata: Goa, University campus, Taleigao, 8.7.1993, Rupa 4; 30.7.1993, Rupa 31.

5. **Lindernia hyssopioides** (L.) Haines, Bot. Bih. Or. 635. 1922; Philcox in Kew Bull. 22: 50. 1968; Sivarajan & Mathew in J. Bombay nat. Hist. Soc. 80: 136. 1983; Almeida, Fl. Savantwadi 1: 300. 1990. *Gratiola hyssopioides* L., Mant. Pl. 174. 1771. *Ilysanthes hyssopioides* (L.) Benth. in DC. Prodr. 10: 419. 1846; Cooke, Fl. Bombay 2: 368. 1967 (repr. ed.).

An erect herb found growing in moist situations and paddy fields, often occupying larger areas. Flowers violet in colour with white base. Very much similar to *L. parviflora.*

Fl. & Fr.: August-January.

Exsiccata: Goa, Benaulim, 29.8.1993, Rupa 29.

6. **Lindernia parviflora** (Roxb.) Haines, Bot. Bih. Or. 635. 1922: Sivarajan & Mathew in J. Bombay nat. Hist. Soc. 49: 38. 1950; Rao, Fl. Goa, Diu, Daman,

Dadra & Nagarhaveli 2: 302. 1986; Almeida, Fl. Savantwadi 1: 301. 1990. *Gratiola parviflora* Roxb., Pl. Cor. 3: 3, t. 204. 1811. *Ilysanthes parviflora* (Roxb.) Benth., Scroph. Ind. 34. 1846; Cooke, Fl. Bombay 2: 368. 1967 (repr. ed.).

Grows mostly in shallow ponds, marshy places and paddy fields. Flower colour varies from white to blue. Rao (l.c.) recorded this species from Nagarhaveli but not from Goa region.

Fl. & Fr.: July-August.

Exsiccata: Goa, University campus, Taleigao, 21.7.1993, Rupa 7; Marcel, 15.8.1993, Rupa 17.

7. **Lindernia rotundifolia** (L.) Alston in Trimen, Handb. Fl. Ceylon 6 (Suppl.): 214. 1931; Sivarajan & Mathew in J. Bombay nat. Hist. Soc. 80: 135. 1983; Almeida, Fl. Savantwadi 1: 301. 1990. *Gratiola rotundifolia* L., Mant. Pl. 274. 1771. *Ilysanthes rotundifolia* (L.) Benth. in DC., Prodr. 10: 420. 1846.

This erect or prostrate herb is strikingly different in its ovate — orbicular, 3-nerved leaves. Common in marshy or moist areas.

Fl. & Fr.: August-January.

Exsiccata: Goa, Marcel, 15.8.1993, Rupa 21.

8. **Lindernia tenuifolia** (Colsm.) Alston var. **pygmaea** Sivarajan & Mathew in J. Bombay nat. Hist. Soc. 80: 134. 1983.

A tufted herb; similar to *L. tenuifolia* var. *tenuifolia* but for its dwarf size. Specimens show lot of variations especially with regard to their leaf shape and size. Found growing with typical variety in marshy places. Very rare.

Fl. & Fr.: August.

Exsiccata: Goa, Marcel, 15.8.1993, Rupa 22.

9. **Mecardonia procumbens** (Mill.) Small, Fl. Southeast U.S. 1065 & 1338. 1903; Saldanha in Saldanha & Nicolson, Fl. Hassan 523. 1976. *Erinus procumbens* Mill., Gard. Dict. ed. 8. n.6. 1768.

A small erect or prostrate herb; sepals unequal; corolla yellow. This exotic weed has been recorded sporadically from Peninsular India.

Fl. & Fr.: August-September.

Exsiccata: Goa, University campus, Taleigao, 21.8.1993, Rupa 27.

10. **Microcarpaea minima** (Koen.) Merr. in Philipp. J. Sci. 7: 100. 1912; Almeida, Fl. Savantwadi 1: 302. 1990. *Paederota minima* Koen. in Retz. Obs. Bot. 5: 10. 1789. *Microcarpaea muscosa* R. Br., Prodr. 436. 1810; Santapau in J. Bombay nat. Hist. Soc. 49: 48. 1950.

A small prostrate herb forming dense mats in moist fallow fields and paddy fields after harvest. Resembles *Dentella* spp. of Rubiaceae.

Fl. & Fr.: December-February.

Exsiccata: Goa, Taleigao, Rupa 50.

ACKNOWLEDGEMENTS

We thank the authorities of BSI and MH for granting permission to consult herbaria and libraries. We also thank Prof. V.V. Sivarajan, Department of Botany, Calicut University for confirming the identity of *Lindernia* spp. and Dr. S.R. Yadav, Reader and Head, Department of Botany, Goa University for his help in various ways.

June 16, 1994

RUPA A. KULKARNI
M.K. JANARTHANAM
Department of Botany,
Goa University, Goa-403 203.

39. *KICKXIA INCANA* (WALL.) PENNELL. (SCROPHULARIACEAE) — A NEW PLANT RECORD FOR KARNATAKA

Specimens of *Kickxia incana* (Wall.) Pennel. (Scrophulariaceae) have been collected during a critical survey of the flora of North-Western Karnataka, and it forms a new record for the state of Karnataka. Description of the species along with notes are provided here. The specimens are deposited in the Herbarium of Botany Department, Shivaji University, Kolhapur.

Kickxia incana (Wall.) Pennell, Scroph. West. Himal. 59. 1943; Sant. in J. Bombay nat. Hist. Soc. 49: 27. 1950; Almeida, Fl. Sawantwadi. 1: 295, 1990. *Linaria incana* Wall., Pl. As. Rar. 2: 43. 1831. *L.*

cabulica Benth. in DC., Prodr. 10: 270. 1846; Cooke, Fl. Pres. Bombay 2: 354, 1905. *L. cabulica* var. *pubescens* Hooker f. in Fl. Brit. India 4: 251. 1883.

Hairy, much branched herb. Stem herbaceous, aerial, terete, diffuse-prostrate, trailing, 10-40 cm long. Leaves triangular-ovate, lower leaves 3-7 lobed, opposite, upper leaves entire, alternate, main nerves 5-7, hairy on both surfaces, 0.3-4.2 x 0.3-3.0 cm, exstipulate, petiolate, petiole 0.2-1.5 cm long, hairy. Flowers solitary, axillary, ebracteate, pedicel 5-9 mm long, filiform, hairy, bent at apex; calyx polysepalous densely hairy, sepals linear — lanceolate, acute, membraneous; corolla yellow, personate, spurred, corolla tube 4.5-7.5 mm long, pubescent-hairy at outer side, spurred at base, spur 2-3 mm long, lower lip 3 lobed, upper lip slightly shorter than lower lip. Stamens 4, didynamous, filaments glabrous, style stout, stigma capitate, ovules many. Capsule ovoid or globose with persistant calyx. Seeds numerous, minute, angular, rugose, brown-black.

Note: Growing on walls of old forts, houses, temples and in crevices of rocks at Rajhunsgad fort in Belgaum District. The species was only found on the highest parts of the hills.

Flowering: September-December.

Fruiting: October-January.

Distribution: The species has been reported from Purandhar fort (Santapau 1957), Mahabaleshwar (Bole and Almeida 1985, Deshpande *et al.* 1993) and Savantwadi (Almeida 1990) of Maharashtra State.

Specimens observed: MPB-4715, Sant.-22879 (BLAT), SMA-26.

ACKNOWLEDGEMENTS

We thank the Director, Royal Botanic Gardens, Kew for confirming the identification of the species and Professor M.S. Patil, Head of Botany Department, Shivaji University, Kolhapur for providing facilities.

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M. P. BACHULKAR
Department of Botany, Vivekanand College,
Kolhapur-416 003.
S. R. YADAV
Department of Botany, Goa University,
Goa -403 203.
S. K. LIMAYE
Aryangla Vaidyak Mahavidyalaya,
Satara-415 002.

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SANTAPAU, H. (1957): The Flora of Purandhar. BSI. Calcutta: 90-91.

40. *DORSTENIA INDICA* WIGHT (MORACEAE) — A NEW PLANT RECORD FOR MAHARASHTRA

Well established strands of *Dorstenia indica* Wight (Moraceae) have been observed during repeated excursions to Saptashrungi hills of Nashik District, Maharashtra at an altitude of 800 metres. Collections were made for its complete study. The identity of this species is confirmed and as it forms a new record for Maharashtra, description along with notes are provided here. The specimens are deposited in the Herbarium of Botany Department, Shivaji University, Kolhapur.

Dorstenia indica Wight, l.c. Pl. Ind. Or. 6: 1964. 1843; Bur. In DC., Prod. 17: 272.1873; Hook. f., Fl.Br.Ind.5: 494.1890; Trimen, Handb. Fl. Ceylon 4: 102. 1898; Gamble, Fl. Pres. Madras 3: 1370. 1928; Fyson, Fl. South Ind. Hill Stations 1: 542, f. 474. 1932; Fischer, Fl. Pres. Madras 8: 958. 1956.

Succulent herb, 7.5-25 cm high. Stems fleshy, tapering, curved ascending, unbranched but proliferating from the base, rooting from the underside, sparsely hairy, latex white. Leaves petiolate, simple, alternate, obovate-lanceolate, 5-8.5 cm long, acuminate, sinuate toothed, membranous, puberulous or glabrous, petiole 1-2.5 cm long. Inflorescence solitary, axillary, somewhat decurved, yellowish-green. Receptacle 0.8-1.5 cm across, peltate, broadly obconic, rounded or angular with 5-12 linear arms. Male flowers numerous, 0.5 mm high; Perianth with two slight lobes; stamens 1-2. Female flowers immersed in the disc, opening before the male; perianth vaguely 2-lobed; ovary stalked, stigma bifid, syncarp fleshy, extruding the small crustaceous seeds; seed 2 mm long, minutely papillate.

Note: Plants grow on soil under shade of forest trees as well as on the trunks and crevices of trees.

Flowering: July-September.

Fruiting: September-October.

Distribution: The species is reported from Nilgiri, Pulney (=Palnis) and Dindigule (=Dindigul) mountains (Hooker 1988, Fyson 1932) and also from Sri Lanka (Dassanayake and Fosberg 1981).

Specimens observed: DNS-4027; BRP-4028

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January 5, 1995

D.N. SHINDE
Department of Botany, Karmveer Kakasaheb Wagh College,
Pimpalgaon (Basawant)-422209.
B.R. PAWAR
Department of Botany, Arts, Science and Commerce College, Satana-423301.
M.S. PATIL
Department of Botany, Shivaji University, Kolhapur-416004.

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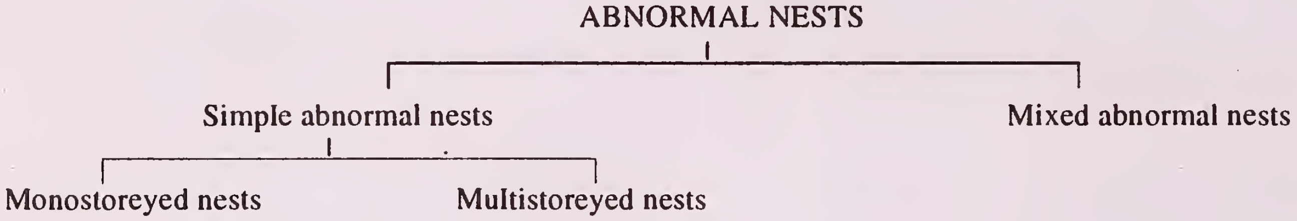
ERRATA

Vol. 92, No. 1

A STUDY OF ABNORMAL NESTS OF BAYA WEAVER BIRD *PLOCEUS PHILIPPINUS* (LINN.) IN RAJASTHAN

On p. 69, diagram,

The "multistoreyed nests" is a subkind of simple abnormal nests and not of "mixed abnormal nest". Therefore the correct classification of nest would be like follows:


ABNORMAL NESTS
Simple abnormal nests
Mixed abnormal nests
Monostoreyed nests
Multistoreyed nests

Vol. 92. No. 2

Miscellaneous Note No. 23. Length record of the common wolf snake (*Lycodon aulicus*) from Bharuch, Gujarat.

On p. 271, para 2, line 7,

For divided into ventrals 232 and caudals 51.

Read ventrals 232 and caudals 51 divided.

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